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1896-97



Columbia University
in the City of New York

SCHOOL OF PURE SCIENCE

COURSES

IN

MATHEMATICS, MECHANICS, PHYSICS, CHEMISTRY,
MINERALOGY, ASTRONOMY, PALÆONTOLOGY,
GEOLOGY, ZOÖLOGY, BOTANY,
PHYSIOLOGY, ANATOMY,
BACTERIOLOGY

LEADING TO THE DEGREES OF MASTER OF ARTS AND
DOCTOR OF PHILOSOPHY

1896-97

THE LIBRARY
OF THE
UNIVERSITY OF ILLINOIS

NOTE

The courses detailed in this pamphlet may be taken as major or minor subjects for the degrees of A. M. and Ph.D., and some of them for the degree of A.B. Other courses leading to the degrees of A.M. and Ph.D. are given under the various faculties, especially the Faculty of Political Science and the Faculty of Philosophy. A combination of courses under the Faculties of Law and Political Science leads to the degree of LL.M.

In addition to the courses offered by these Faculties, Columbia University offers the following :

In COLUMBIA COLLEGE :

A four-years' course leading to the degree of A.B.

In the SCHOOL OF LAW :

A three-years' course leading to the degree of LL.B.

In the SCHOOL OF MEDICINE (College of Physicians and Surgeons) :

A four-years' course leading to the degree of M.D.

In the SCHOOL OF MINES :

A four-years' course in Mining Engineering leading to the degree of E.M.

“ “ Civil Engineering “ “ C.E.

“ “ Sanitary Engineering “ “ C.E.

“ “ Electrical Engineering “ “ E.E.

“ “ Metallurgy “ “ Met.E.

“ “ Chemistry “ “ B.S.

“ “ Architecture “ “ B.S.

The first-year courses of the School of Law, the School of Medicine, and the School of Mines, are open, as electives, to Seniors in the College. Consequently, such Seniors as may desire to do so, can prepare themselves for advanced standing in those schools, by electing these first-year courses and counting them for the degree of A.B.

Information and circulars as to any of the above courses may be had by addressing the Secretary of the University.

The catalogue of the University is published in December and is sold at twenty-five cents a copy.

All the schools and departments of Columbia University are at Madison Avenue and 49th Street with the exception of the departments of Zoölogy, Physiology, Anatomy, Bacteriology, and other departments of the School of Medicine which are at Tenth Avenue and 59th Street.

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SCHOOL OF PURE SCIENCE

FACULTY OF PURE SCIENCE

NAMES	RESIDENCES
SETH LOW, LL.D. President of Columbia University	Columbia University
J. HOWARD VAN AMRINGE, Ph.D. L.H.D. Professor of Mathematics	66 West 47th St.
OGDEN N. ROOD, A.M. Professor of Physics	41 East 49th St.
THOMAS EGGLESTON, E.M., Ph.D., LL.D. Professor of Mineralogy and Metallurgy	35 West Washington Sq.
CHARLES F. CHANDLER, Ph.D., M.D., LL.D. Professor of Chemistry	51 East 54th St.
JOHN K. REES, A.M., E.M., Ph.D. "The Dakota," Professor of Astronomy, and Director of the Observatory	1 West 72d St.
JOHN G. CURTIS, A.M., M.D. Professor of Physiology	327 West 58th St.
ALFRED J. MOSES, E.M., Ph.D. Adjunct Professor of Mineralogy	41 East 49th St.
NATHANIEL L. BRITTON, E.M., Ph.D. Professor of Botany, and Secretary of the Faculty	41 East 49th St.
GEORGE S. HUNTINGTON, M.D. Professor of Anatomy	50 East 73d St.
HENRY FAIRFIELD OSBORN, Sc.D. Da Costa Professor of Zoölogy	850 Madison Ave.
EDMUND B. WILSON, Ph.D. Professor of Invertebrate Zoölogy	41 East 49th St.
JAMES F. KEMP, A.B., E.M. Professor of Geology	41 East 49th St.
WM. HALLOCK, A.B., Ph.D. Adjunct Professor of Physics	428 Central Park, West
MICHAEL I. PUPIN, Ph.D. Adjunct Professor of Mechanics	46 West 72d St.

NAMES	RESIDENCES
T. MITCHELL PRUDDEN, M.D. Professor of Pathology	160 West 59th St.
ROBERT S. WOODWARD, C.E., Ph.D. Professor of Mechanics, and Dean of the Faculty	183 Claremont Ave., Montclair, N. J.
THOMAS S. FISKE, A.M., Ph.D. Adjunct Professor of Mathematics	328 West 57th St.
HAROLD JACOBY, A.B., Ph.D. Adjunct Professor of Astronomy	15 West 53d St.
FRANK N. COLE, Ph.D. Professor of Mathematics	50 Montclair Ave., Montclair, N. J.
FREDERIC S. LEE, Ph.D. Adjunct Professor and Demonstrator of Physiology	437 West 59th St.

Other Officers

PIERRE DE P. RICKETTS, E.M., Ph.D. Professor of Analytical Chemistry and Assaying	115 East 79th St.
CHARLES E. COLBY, E.M., C.E. Adjunct Professor of Organic Chemistry	1933 Madison Ave.
CHARLES E. PELLEW, E.M. Demonstrator of Chemistry and Physics	68 East 54th St.
ROBERT A. SANDS, M.D. Assistant Demonstrator of Anatomy	39 East 33d St.
WINFIELD JOHNSON, Ph.G. Assistant Demonstrator of Chemistry and Physics	437 West 59th St.
JAMES S. C. WELLS, Ph.D. Instructor in Qualitative Analysis	Box 29, Hackensack, N. J.
FERDINAND G. WIECHMANN, Ph.D. Instructor in Chemical Philosophy and Chemical Physics	41 East 49th St.
BASHFORD DEAN, Ph.D. Instructor in Biology	41 East 49th St.
TIMOTHY M. CHEESMAN, M.D. Instructor in Bacteriology	46 East 29th St.
LOUIS H. LAUDY, Ph.D. Tutor in General and Applied Chemistry	41 East 49th St.
REGINALD GORDON, A.B. Tutor in Physics	76 Park Ave.
HENRY C. BOWEN Tutor in Quantitative Analysis	212 East 50th St.
J. C. PFISTER, A.B. Tutor in Mechanics	Newark, N. J.
LEA MCL. LUQUER, C.E., Ph.D. Tutor in Mineralogy	41 East 49th St.

NAMES	RESIDENCES
HERMANN T. VULTÉ, Ph.D. Tutor in Chemistry	41 East 49th St.
CHARLES A. HOLLICK, Ph.B. Tutor in Geology	New Brighton, S. I.
HERSCHEL C. PARKER, Ph.B. Tutor in Physics	21 Fort Greene Pl., Brooklyn, N. Y.
GARY N. CALKINS, B.S., Tutor in Biology	41 East 49th St.
CARLTON C. CURTIS, A.M., Ph.D. Tutor in Botany	41 East 49th St.
J. BRUCE CHITTENDEN, Ph.D. Tutor in Mathematics	41 East 49th St.
JOHN E. HILL Tutor in Mathematics	41 East 49th St.
ALEXANDER R. CUSHMAN, Ph.D., Assistant in Chemistry	128 East 16th St.
ASA S. IGLEHART, A.B., Assistant in Physics	106 East 86th St.
HERBERT P. WHITLOCK, C.E. Assistant in Mineralogy	41 East 49th St.
CHARLES C. TROWBRIDGE, Ph.D. Assistant in Physics	41 East 49th St.
HENRY S. CURTIS, A.B. Assistant in Physics	Buckingham Hotel
NATHAN R. HERRINGTON, A.B. Assistant in Biology	437 West 59th St.
MARSTON T. BOGERT, A.B. Assistant in Chemistry	41 East 49th St.
SAMUEL A. TUCKER, Ph.B. Assistant in Toxicology	437 West 59th St.
GEORGE H. LING, A.M. Assistant in Mathematics	41 East 49th St.
HALBERT P. GILLETTE, M.E. Assistant in Physics	238 West 44th St.
HENRY E. KEYES, Ph.D. Assistant in Physics	41 East 49th St.
GILBERT VAN INGEN Curator of the Geological Collections	244 East 50th St.
JOHN K. SMALL, A.B., Ph.D. Curator of the Herbarium	41 East 49th St.

Delegates to the University Council

THE DEAN, Professor WOODWARD

Professor REES

GENERAL STATEMENT

This Faculty has charge of the University courses of instruction and research in all the branches of Pure Science, and especially the supervision of candidates for the degrees of Masters of Arts and Doctor of Philosophy in Pure Science. Students in the other University Faculties are also at liberty to pursue courses of study and investigation under this Faculty.

Candidates for these degrees taking major subjects in Pure Science will be regarded as under the special jurisdiction of this Faculty, and must apply to the Secretary for registration before entering upon their work. The same registration requirement must also be complied with by candidates who desire to pursue minor or special subjects under this Faculty.

In the Faculty are represented all the departments of the University which give instruction in Pure Science, namely :

DEPARTMENTS	HEADS OF DEPARTMENTS
<i>Mathematics</i>	Professor VAN AMRINGE
<i>Mechanics</i>	Professor WOODWARD
<i>Physics</i>	Professor ROOD
<i>Chemistry, Organic and Inorganic</i>	Professor CHANDLER
<i>Mineralogy</i>	Professor EGLESTON
<i>Astronomy</i>	Professor REES
<i>Geology, including Lithology and Palæontology</i>	Professor KEMP
<i>Zoology</i>	Professor OSBORN
<i>Botany</i>	Professor BRITON
<i>Physiology</i>	Professor CURTIS
<i>Anatomy</i>	Professor HUNTINGTON
<i>Bacteriology</i>	Professor PRUDEN

Students of this and other institutions whose requirements conform to the regulations of Columbia College may be admitted to the Senior courses under this Faculty as candidates for the degree of A.B. They must present testimonials showing an equivalent course of study to the close of the Junior year, or must pass a satisfactory examination upon the studies of the first three years of the College. Candidates for this degree are required to pursue courses of instruction amounting in all to not less than fifteen hours of attendance per week for one year, and must conform to such requirements regarding a thesis as are established for members of the Senior class in the College. Their selection of studies is not confined to those of this Faculty.

Graduate students, candidates for the degrees of A.M. or Ph.D., are subject :

- 1st. To the general regulations of the University Council.
- 2d. To the special regulations of this Faculty.

There are now one hundred and forty courses of instruction offered, a synopsis of which is given upon pages 17-36.

Regulations for the Degrees of Master of Arts and Doctor of Philosophy, established by the University Council

1. Candidates for the degrees of Master of Arts and Doctor of Philosophy must hold a baccalaureate degree in arts, letters, philosophy, or science, or an engineering degree, or an equivalent of one of these from a foreign institution of learning.

The Deans of the several schools will require candidates for the higher degrees to present satisfactory evidence that they are qualified for the studies they desire to undertake.

2. Candidates for the degrees of Master of Arts and Doctor of Philosophy must pursue their studies in residence for a minimum period of one and two years, respectively.* The year spent in study for the degree of Master of Arts is credited on account of the requirement for the degree of Doctor of Philosophy. Residence at other universities may be credited to a candidate. In certain cases and by special arrangement, time exclusively devoted to investigation in the field will be credited in partial fulfilment of the time required. No degree will be conferred upon any student who has not been in residence at Columbia University for at least one year.

3. Each student who declares himself a candidate for the degrees of Master of Arts and Doctor of Philosophy, or either of them, shall, immediately after registration, designate one principal or major subject and two subordinate or minor subjects, which shall be the studies of his University course.

4. The subjects from which the candidate's selection must be made are :

UNDER THE FACULTY OF PHILOSOPHY :

I. *Major Subjects* : 1. Philosophy ; 2. psychology ; 3. education ; 4. linguistics ; 5. literature ; 6. classical archæology and epigraphy ; 7. Greek language, literature, and, incidentally, history ; 8. Latin language and literature, and, incidentally, Roman history ; and the following, *including in each case the study of both the language and the literature* : 9. English ; 10. Germanic ; 11. Romance ; 12. Sanskrit (with Pāli) and Iranian ; 13. Semitic. Nos. 10, 11, 12, and 13 count each as the equivalent of a major and one minor subject.

II. *Minor Subjects* : 1. Philosophy ; 2. psychology ; 3. logic ; 4. education ; 5. anthropology ; 6. linguistics ; 7. literature ; 8. Greek ; 9. Greek archæology ; 10. Latin ; 11. Roman archæology ; 12. Sanskrit ; 13. Iranian ; 14. English ; 15. Anglo-Saxon and Gothic ; 16. Germanic philology ; 17. German language and literature ; 18. Scandinavian languages and literatures ; 19. Romance philology ; 20. French language and literature ; 21. Spanish and Italian languages and literatures ; 22. Hebrew ; 23. Arabic ; 24. Assyrian ; 25. Syriac ; 26. Ethiopic ; 27. Semitic epigraphy.

In his choice of subjects under this Faculty, the candidate is limited by the regulation that not more than two of the three subjects may be selected from those offered by any one department. A major subject will involve attendance

* In practice three years of study is usually necessary to obtain the degree of Doctor of Philosophy.

at lectures and seminars amounting to four or more hours weekly; a minor subject will involve attendance of two or more hours weekly.

UNDER THE FACULTY OF POLITICAL SCIENCE:

Group I.—History and political philosophy: 1. European history; 2. American history; 3. political philosophy.

Group II.—Public law and comparative jurisprudence: 1. Constitutional law; 2. international law; 3. criminal law; 4. administrative law; 5. comparative jurisprudence.

Group III.—Economics and social science; 1. Political economy and finance; 2. sociology and statistics.

In his choice of subjects under this Faculty, the candidate is limited by the regulation that not more than two of the three subjects may be selected from any one of the above groups, and by the following rules:

Candidates offering European history as the major subject, must offer American history as one of the minor subjects, and *vice versa*.

Candidates offering political economy and finance as the major subject, must offer sociology and statistics as one of the minor subjects, and *vice versa*.

Candidates will not be permitted to offer constitutional law alone as the major subject for the degree of Doctor of Philosophy, but must combine with it the course on general international law, or on comparative administrative law.

Candidates offering international law, or criminal law, or administrative law as the major subject, must take constitutional law as one minor subject.

Candidates will not be permitted to offer criminal law alone as the major subject for the degree of Doctor of Philosophy, but must combine with it the course on general international law.

To be recognized as a major subject for the degree of Master of Arts the courses selected must aggregate at least two hours per week throughout the year, and must also include attendance at a seminar; for a minor subject for the degree of Master of Arts, the attendance at a seminar is not required.

To be recognized as a minor subject for the degree of Doctor of Philosophy, courses must be taken, in addition to the requirements for a minor subject for the degree of Master of Arts, aggregating two hours weekly. To be recognized as a major subject for the degree of Doctor of Philosophy, all of the courses and seminars offered in that subject must be taken.

UNDER THE FACULTY OF PURE SCIENCE:

Mathematics; mechanics; astronomy; geodesy; physics; chemistry; mineralogy; geology; palæontology; lithology; zoölogy; botany; physiology; anatomy; bacteriology.

In his choice of subjects under this Faculty, the candidate is limited by the regulation that no two of the subjects selected may be in any one department, unless the consent of the Faculty thereto shall have first been obtained. Candidates are expected to devote at least one-half their time throughout their course of study to the major subject. In the case of laboratory courses this implies two days a week, or its equivalent, as determined by each department. Each minor subject is intended to occupy approximately one-fourth of the time during one year for the degree of Master of Arts, and during one or two years, according to the nature of the subject and the previous training of the

candidate, for the degree of Doctor of Philosophy. Students may distribute the remainder of their time either in courses of major or minor reading in branches where their preparation is least complete, or in researches connected with their major subject.

UNDER THE FACULTY OF MINES :

Mining ; metallurgy ; engineering (civil, mechanical, electrical, and sanitary); and architecture.

The Faculty of the School of Mines requires that at least one minor subject should be taken under the Faculty of Pure Science.

A minor subject may be taken in the same department as the major, but no two minors may be taken in the same department. It is expected that fully half of the students' time throughout the course of study shall be devoted to the major subject, and one-quarter of the time during one year and an equal proportion of the second year, if necessary, to each of the minor subjects.

5. Each student is given a registration book, which is signed by the professor or instructor in charge of each course of instruction or investigation at the beginning and end of every such course. These registration books are to be preserved by students as evidence of work accomplished and should be submitted to the Deans of the several Faculties at the end of each year, that proper credit may be given and entered on the permanent records of the institution.

6. Students desiring to be examined as candidates for any degree must make written application for such examination to the Dean of the proper Faculty, on blank forms provided for the purpose. All such applications must be made on or before April 1st of the academic year in which examination is desired, and must be accompanied by the candidate's registration book, properly signed as above provided.

7. Each candidate for the degree of Master of Arts shall present an essay on some topic previously approved by the professor in charge of his major subject. Before the candidate is admitted to examination the professor in charge of his major subject must have signified his approval of such essay. The Faculty of Philosophy requires that this essay be presented not later than May 1st of the academic year in which the examination is to take place. The Faculty of Political Science requires this essay to be a paper read during the year before the seminar of which the candidate is a member.

8. Each candidate for the degree of Doctor of Philosophy shall present a dissertation, embodying the results of original investigation and research, on some topic previously approved by the Faculty. When such dissertation has been approved by the Faculty, it shall be printed by the candidate, and one hundred and fifty copies shall be delivered to the Faculty, unless, for reasons of weight, a smaller number be accepted by special action of the University Council. On the title-page of every such dissertation shall be printed the words : " Submitted in partial fulfilment of the requirements for the Degree of Doctor of Philosophy, in the Faculty of —————, Columbia University. There shall be appended to each dissertation a statement of the educational institution that the author has attended, a list of the degrees and honors conferred upon him, as well as the titles of any previous publications.

The several Faculties have delegated the power to approve the subject chosen for his dissertation by any candidate for the degree of Doctor of Philosophy, as well as the power to approve the dissertation itself, to the professor in charge of the candidate's major subject.

The Faculty of Philosophy requires the submission and approval of the dissertation before the candidate is admitted to examination.

The Faculty of Political Science requires the dissertation to be submitted not later than April 1st of the academic year in which the examination for the degree is desired. With the consent of the Dean and the professor in charge of the candidate's major subject the examination may be held before the printed dissertation is submitted.

The Faculty of Pure Science requires the dissertation to be submitted not later than the third week in March of the academic year in which the examination is desired; and when printed it must be printed in the size and form either of the *Annals* or *Memoirs* of the New York Academy of Sciences, according to the nature of the subject, and must be delivered to the Faculty before the final examination.

The Faculty of Mines requires the dissertation to be submitted for approval not later than April 1st and that it be printed in the size and style of the *School of Mines Quarterly*, and delivered to the Faculty not later than May 1st of the academic year in which the examination is to take place.

9. Every candidate for the degree of Doctor of Philosophy, in addition to passing such other examinations as may be required by the Faculty, shall be subjected to an oral examination on his major subject, and shall defend his dissertation, in the presence of the entire Faculty or of so many of its members as may desire to attend. The ability to read at sight Latin, French, and German is required by the Faculties of Philosophy and Political Science; the ability to read at sight French and German is required by the Faculties of Pure Science and of the School of Mines, to be certified in each case by the Dean of the Faculty concerned.

10. Students holding college degrees, who shall have completed with marked distinction one of the regular courses in the School of Law, the School of Medicine, or the School of Mines, may be recommended for the degree of Master of Arts; provided that in each case the candidate presents a satisfactory dissertation, and that at least a part of the extra work required of him for the degree of Master of Arts be taken under the direction of either the Faculty of Philosophy, the Faculty of Political Science, or the Faculty of Pure Science, to the extent of a minor course for not less than one year.

Special Regulations of the Faculty of Pure Science

The degree of Doctor of Philosophy is awarded on the basis of a thorough training in the methods of advanced work and investigation in some branch of science. The following statements are offered for the guidance of students. In the case of students of especial ability or exceptional previous training, the Faculty may modify its usual regulations.

The student is expected to gain a sound general knowledge of the two minor subjects of his choice. In the major subject a much more thorough and special knowledge is required, especial importance being attached to training in research. In order to avoid undue specialization, no two "subjects" can be chosen from the same "department" without the consent of the Faculty. (See Departmental Statements on pp. 17-36.)

One year's study in residence in the University is required for the degree of Master of Arts, and three years' study for the degree of Doctor of Philosophy, at least one year of which shall be in residence. Candidates for either of these degrees are expected to devote at least one-half their time throughout their course of study to the major subject. In the case of laboratory courses this implies two days a week, or its equivalent, as determined by each department. Each minor subject is intended to occupy approximately one-fourth of the time during one year for the degree of Master of Arts, and during one or two years, according to the nature of the subject and the previous training of the candidate, for the degree of Doctor of Philosophy. Students may distribute the remainder of their time either in courses of major or minor reading in branches where their preparation is least complete, or in researches connected with their major subject.

It should be understood that both the major and the minor examinations may cover assigned work not included in the regular lecture or laboratory courses. It is expected that the third year of study, and in certain cases both the second and the third years, will be wholly devoted to the major subject and to investigation for the dissertation.

As regards the "essay" required for the degree of Master of Arts, and the "dissertation" for the degree of Doctor of Philosophy, the approval of the subject for investigation, as well as the essay or dissertation itself, rests with the instructor in charge of the candidate's major subject. It is desirable to make these studies consecutive, and treat them, respectively, as preliminary and completed investigations. Great importance is attached to the character of the final dissertation. While it must depend for acceptance chiefly on the subject-matter, it should show good literary workmanship, especially by directness and clearness of statement. It should demonstrate the author's capacity to do original scientific work and to render an intelligible account thereof. It should evince a familiarity with the literature of the subject and with the latest methods of research applicable to it. The treatment should be as concise as the nature of the work permits. Every dissertation should be preceded by a clear introductory statement setting forth the nature and the scope of the research, and be followed by a resumé of the results and the conclusions obtained. It should also be accompanied by a table of contents and by a list of the authorities consulted in its preparation.

The dissertations are to be submitted by the third week of March. They are to be distributed to the Faculty before the final examination. The essay for the degree of Master of Arts must be submitted on or before May 15th.

Examinations

Applications to be examined for the degree of Master of Arts or Doctor of Philosophy must be made on or before April 1st of the academic year in which the examination is desired. The examination shall be oral, or at least in part, and in the case of candidates for the degree of Doctor of Philosophy the dissertation must be publicly defended in the presence of the Faculty or of so many of the members as may desire to attend. The instructors in charge of the major and minor subjects must be present and conduct the examination.

At the time of the final examination for the degree of Doctor of Philosophy candidates will be expected to read scientific works in French and German at sight.

RECORD—At the close of each course the instructor in charge shall enter in the registration book the record of the student, and at the close of each academic year each student shall exhibit his registration book to the Secretary for record.

Special Students

Students who are not candidates for a degree may be permitted to pursue such courses from among those offered by this Faculty as they may be found qualified to enter upon. Each applicant must demonstrate his preparation for, and his ability to pursue, the courses selected, and of his qualifications the heads of the departments in which he proposes to study shall be the judges. In general these special courses are open only to advanced students.

Admission

Every student, on first entering Columbia University, is required to pay a matriculation fee of \$5, and to sign the matriculation book in the office of the President, as an indication of his willingness to be bound by the rules and regulations adopted for the government of students, either by the Trustees or by the Faculty.

After matriculation in the President's office the student shall register in the office of the Secretary of the Faculty, and enter in his registration book the courses he desires to pursue. This selection of courses will be subject to the approval of the Dean. His application will then be referred to the head of each department concerned, and upon approval of his qualifications for the courses selected, he will be recorded as a student under this Faculty.

University Fellowships

The twenty-four fellowships established in the University are tenable for one year, with a possibility of reappointment for two successive years for reasons of weight. Applications for fellowships should be addressed to the President of Columbia University. By the advice of the University Council the following rules have been adopted regarding the fellowships :

- 1 The application shall be made prior to March 1st, in writing, addressed to the President of Columbia University. Applications received later than

March 1st may fail of consideration. The term of the fellowship is one year, dating from July 1st. Residence should begin October 1st.

2 The candidate must give evidence

(a) of a liberal education, such as a diploma already granted, or about to be received, from a college or scientific school of good repute ;

(b) of decided fitness for a special line of study, such as an example of some scientific or literary work already performed ;

(c) of upright character, such as a testimonial from some instructor.

3 The value of each fellowship is \$500. Payments will be based on the time during which the fellow shall have been in residence. The holder of a fellowship is exempt from the charges for tuition.

4 Every holder of a fellowship will be expected to perform such duties as may be allotted to him in connection with his course of study, which course will be such as to lead to the degree of Doctor of Philosophy. He will be expected to devote his time to the prosecution of special studies under the direction of the head of the department to which he belongs, and before the close of the academic year to give evidence of progress by the preparation of a thesis, the completion of a research, the delivery of a lecture, or by some other method. He must reside in New York or vicinity during the academic year.

5 No holder of a fellowship shall be permitted to pursue a professional or technical course of study during his term. With the written approval of the President, but not otherwise, he may give instruction or assistance in any department of the University.

6 No fellow shall be allowed to accept remunerative employment except by written permission of the President, and the acceptance of any such employment, without such permission, shall operate to vacate the fellowship.

7 A fellow may be reappointed at the end of a year for reasons of weight. No fellow may be reappointed for more than two terms of one year each.

8 As these fellowships are awarded as honors, those who are disposed, for the benefit of others or for any other reason, to waive the pecuniary emolument, may do so, and still have their names retained on the list of fellows.

University Scholarships

There have been established by the Trustees of Columbia University thirty University scholarships, to be awarded annually to students in the University Faculties of Political Science, Philosophy, and Pure Science. These scholarships are awarded under the following regulations, prepared by the authority of the University Council and with its approval :

1 The University scholarships are open to all graduates of colleges and scientific schools whose course of study has been such as to entitle them to be enrolled at Columbia as candidates for a University degree. (See catalogue of 1895-6, pp. 21-32.)

2 These scholarships are tenable for one academic year, with a possibility of renewal for one year longer. They are of an annual value of \$150 each.

3 Payments will be made to University scholars in two equal instalments ; one on October 1st and one on February 1st. University scholars will be required to pay all of the fees established for matriculation, tuition, and graduation.

4 Applications for University scholarships should be made in writing, on blanks that will be furnished for the purpose, and addressed to the President of Columbia University. For the scholarships to be awarded in the spring, applications should be filed not later than May 1st. No application for a University scholarship will be required from an applicant for a University fellowship. Should a scholarship be awarded to an unsuccessful applicant for a fellowship, the only information required from the candidate will be that contained in the formal application for the latter honor.

5 Not more than twenty of the University scholarships will be awarded by the University Council at its regular meeting in May. The award will be made after applications have been examined and recommendations made by the standing committee on University fellowships. In making these recommendations the committee will give preference to those candidates for University fellowships who have failed of appointment by the University Council after having been recommended for the same by any Faculty or department.

6 At least ten University scholarships will be reserved to be filled in the autumn, and applications for the same will be received up to October 1st.

7 University scholars will be required to enroll themselves as candidates for a degree and to pursue a regular course of study leading thereto.

John Tyndall Fellowship

There is a fellowship known as the "John Tyndall Fellowship for the Encouragement of Research in Physics," which is awarded to some suitable person, either a graduate of or a student in the College, but not necessarily a candidate for a degree. Such fellow is appointed by the Council upon the recommendation of the head of the Department of Physics. The appointment is for a term of one year only, but the fellow for the time being is eligible for appointment from year to year upon like recommendation. The fellow so appointed is entitled to receive during his term of office the net income of the capital sum constituting the endowment, to be paid in four quarterly instalments on the usual quarter days, upon the certificate of the President ; and the Trustees guarantee that such net income will amount to at least six hundred and forty-eight dollars a year, being six per cent. upon ten thousand eight hundred dollars, the sum presented to the University by Professor Tyndall.

Barnard Fellowship

A fellowship known as the "Barnard Fellowship for Encouraging Scientific Research" is held by a graduate of the College or the School of Mines who has evinced decided aptness for physical investigation and who may be disposed to devote himself to such investigation for some years continuously. Such fellow shall be appointed by the Council upon the joint recommendation

of the Faculties of the College and the School of Mines. Such appointment shall be for the term of one year only, but the fellow for the time being shall be eligible to reappointment from year to year upon like joint recommendation. The fellow so appointed shall be entitled to receive during his term of office the net income of the capital sum constituting the endowment, to be paid to him in four equal quarterly instalments on the usual quarter days, upon the certificate of the President.

It shall be the duty of a Barnard or John Tyndall fellow to devote himself faithfully to the investigation of some subject in physical science at this University, or at some other in this country or abroad, under the supervision of some known physicist approved by the President and the head of the Department of Physics. He shall make a report quarterly to the President, giving an account of the work in which he has been engaged during the three months preceding; which report shall be certified by the physicist superintending and directing him. In case of failure faithfully to fulfil the obligations imposed upon him, such fellow shall forfeit all privileges and emoluments conferred upon him by his appointment to the fellowship, and the Council may at any time declare the fellowship to be vacant.

Fees

The following fees are established by the Trustees:

For candidates for the degree of Bachelor of Arts in the School of Pure Science	per annum	\$200
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For candidates for the degrees of Master of Arts and Doctor of Philosophy	per annum	150
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For students pursuing partial courses, at the rate of \$15 per annum for each hour of attendance per week on lectures or recitations, with a maximum fee of		150
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For auditors, at the rate of \$20 per annum for each hour of attendance per week on lectures or recitations, with a maximum fee of		200
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For examinations:

For examinations at unusual times	5
For the Bachelor's degree (not professional or technical)	15
For any professional or technical degree	25
For the degree of Master of Arts	25
For the degree of Doctor of Philosophy	35

Payment of Fees

Candidates for a degree, after filling in the blank provided for the purpose, and obtaining the signature of the Dean of the proper Faculty thereto, should present the same to the Treasurer, with the proper fee. Students intending to pursue a partial course must have the amount of the tuition fee certified by the Dean of the proper Faculty, before the fee will be received.

Students entering the University for the first time are required to pay a matriculation fee of \$5, and to matriculate in the President's office by writing their names in the matriculation book. Such students must personally present, as evidence of their right to matriculate, the Treasurer's receipt upon the form provided for all required fees.

Every student holding a scholarship, or receiving the benefit of free or reduced tuition, is required to file with the Secretary of the University a certificate to that effect, from the Dean of the Faculty with which he is registered.

No student is permitted to attend any academic exercise until he has complied with the regulations in regard to matriculation and registration.

Combinations of Courses of Study

Subject to the preceding regulations and to the approval of the instructors concerned, students under this Faculty are at liberty to choose from the following departmental statements any combination of courses they may be qualified to pursue. They are also at liberty to select one minor course in either of the other Graduate Schools, whose tender of subjects is outlined on pp. 6, 7. For the benefit of intending students, especially those who desire to study for degrees, a partial list of combinations of courses is given below, these combinations being such as will in general meet the approval of the departments concerned. The courses which may be counted as majors or minors in any subject are specified in the detailed departmental statements given on pp. 17-36.

TABLE SHOWING PARTIAL LIST OF COMBINATIONS OF COURSES.

MAJOR SUBJECT	MINOR SUBJECTS	
Mathematics	Astronomy Astronomy Physics Physics	Mechanics Physics Mechanics Chemistry
Mechanics	Mathematics Mathematics Physics Physics	Physics Astronomy Astronomy Chemistry
Physics	Mathematics Physiology Chemistry Chemistry	Mechanics Zoölogy Mineralogy Mechanics
Chemistry	Physics Physics Mathematics Botany	Mineralogy Geology Mechanics Zoölogy
Mineralogy	Chemistry Chemistry Mathematics Botany	Physics Geology Physics Zoölogy

TABLE SHOWING PARTIAL LIST OF COMBINATIONS OF COURSES—*Continued.*

MAJOR SUBJECT	MINOR SUBJECTS	
Astronomy	Mathematics Mathematics Physics Mathematics	Mechanics Physics Mechanics Chemistry
Geology	Physics Zoölogy Mineralogy Astronomy	Chemistry Botany Mechanics Physics
Zoölogy	Botany Geology Physiology Bacteriology	Physiology Palæontology Chemistry Chemistry
Botany	Zoölogy Zoölogy Zoölogy Physics	Geology Bacteriology Physiology Chemistry
Physiology	Anatomy Zoölogy Botany Physics	Zoölogy Botany Bacteriology Chemistry
Anatomy	Physiology Zoölogy Physiology Physics	Zoölogy Botany Palæontology Chemistry
Bacteriology	Zoölogy Zoölogy Botany Physics	Botany Physiology Chemistry Chemistry

DEPARTMENTAL STATEMENTS OF COURSES OF STUDY.

Department of Mathematics

Collegiate Courses

I.—ANALYTICAL GEOMETRY (Wentworth's)—3 hours. Professor VAN AMRINGE.

Elective for Juniors and Seniors in the College.

II—PROJECTIVE GEOMETRY—2 hours. MR. HILL

Elective for Juniors and Seniors in the College.

III—THEORY OF EQUATIONS AND SOLID ANALYTICAL GEOMETRY—3 hours. MR. HILL.

Elective for Seniors in the College who have taken I.

IV—DIFFERENTIAL AND INTEGRAL CALCULUS (Osborne's)—3 hours. Professor VAN AMRINGE.

Elective for Juniors and Seniors in the College who have taken I.

University Courses

XIII.—SPECIAL TOPICS IN DIFFERENTIAL AND INTEGRAL CALCULUS—3 hours, first term. Dr. CHITTENDEN

For A.M. and Ph.D. Half minor for A.M.

XIV—DIFFERENTIAL EQUATIONS AND APPLICATIONS—3 hours, second term. MR. HILL

For A.M. and Ph.D. Half minor for A.M.

XV—HIGHER PLANE CURVES—3 hours, first term. MR. HILL

For A.M. and Ph.D. Half minor for A.M.

XVI—THEORY OF INVARIANTS—3 hours, second term. Dr. CHITTENDEN

For A.M. and Ph.D. Half minor for A.M.

XVII—ANALYTICAL THEORY OF CURVES OF DOUBLE CURVATURE AND CURVED SURFACES—3 hours. MR. MACLAY

For A.M. and Ph.D.

XVIII—THEORY OF SUBSTITUTIONS—3 hours. Professor COLE

For A.M. and Ph.D. Not given in 1896-7.

XIX—GENERAL THEORY OF FUNCTIONS—3 hours. Professor FISKE

For A.M. and Ph.D. Not given in 1896-7.

XX—THEORY OF THE COMPLEX VARIABLE, AND ELLIPTIC FUNCTIONS—3 hours. Professor COLE

For A.M. and Ph.D.

XXI—THEORY OF NUMBERS—3 hours. Mr. LING

For A.M. and Ph.D.

XXII—THEORY OF FUNCTIONS (SECOND COURSE)—3 hours. Professor FISKE

For A.M. and Ph.D.

MINORS—The requirement for a minor for the degree of A.M. is a course, or courses, equivalent to three hours a week during one year.

The requirement for a minor for the degree of Ph.D. is a course, or courses, equivalent to three hours a week during three years.

MAJORS—The requirement for a major for the degree of A.M. is a course, or courses, equivalent to six hours a week during one year.

The requirement for a major for the degree of Ph.D. is a course, or courses, equivalent to six hours a week during three years.

Department of Mechanics

Collegiate Courses

I—ANALYTICAL MECHANICS—As a text for this subject, Rankine's Applied Mechanics is used—attention being confined chiefly, however, to Part I, Principles of Statics (including hydrostatics); Part III, Principles of Kinematics; and Part V, Principles of Dynamics (including hydrodynamics). The text is supplemented by lectures on special topics, by written solutions and discussions of typical problems, and by demonstrations with the aid of apparatus. Particular attention is given to the doctrine of units and dimensions of units, and to problems affording actual applications of principles. 3 hours. Professor WOODWARD

Required of students in Civil, Mining, Mechanical, and Electrical Engineering; and it is recommended to all students who may desire to pursue the higher applications of the science in dynamical astronomy, electricity, magnetism, thermodynamics, elasticity, and physical geodesy.

II—ELEMENTARY MECHANICS—Loney's Elements of Statics and Dynamics is used as a text. This work is supplemented by demonstrations with apparatus, by lectures on the theory of dimensions and units, and by lectures, chiefly historical, on the higher applications and results of the science. 2 hours. Mr. PFISTER

Offered especially as an elective to students of the Junior year in the College. It is designed to afford as good a knowledge of the science as can be had without the calculus. It assumes that the student has passed in Course I of the Department of Mathematics, or its equivalent.

University Courses

III—THEORETICAL MECHANICS—Ziwet's Elementary Treatise on Theoretical Mechanics is used as a text. This requires familiarity with the elements of the differential and integral calculus. 2 hours. Mr. PFISTER

Designed to be supplementary to Course II, and is offered as an elective to those desiring a knowledge of the general principles of the science rather than the special principles essential to engineering.

IV—THERMODYNAMICS, with special reference to its bearing on the theory of heat engines—3 hours, first term. Professor PUPIN

Required of all students in Engineering.

V—ELEMENTARY THERMODYNAMICS—The ground covered by this course is indicated by Maxwell's Theory of Heat, which is used as a text. In addition, lectures are given on the more advanced principles and results of the science. 2 hours, first term. Mr. PFISTER

Offered as an elective to students of the fourth year in the College, and to graduates. Its pre-requisite is Course II, or an equivalent.

VI—THEORY OF DYNAMO AND MOTOR (INTRODUCTORY), covering elements of the theory of electric, magnetic, and electro-dynamic potential, theory of electro-magnetic and electro-dynamic induction, and its application to the theory of an ideal dynamo.—3 hours, first term. Professor PUPIN

Required of students in Electrical Engineering.

VII—THEORY OF DIRECT-CURRENT DYNAMO AND MOTOR, covering Hopkinson's theory of dynamo and motor designing, and Froehlich's method of dynamo and motor testing.—3 hours, second term. Professor PUPIN

Required of students in Electrical Engineering.

VIII—THEORY OF ALTERNATORS AND TRANSFORMERS—3 hours, first term. Professor PUPIN

Required of students in Electrical Engineering.

IX—THEORY OF VARIABLE CURRENTS, particularly the theory of poly-phase and of high frequency and high potential currents. 3 hours, second term. Professor PUPIN

Required of students in Electrical Engineering.

NOTE—Courses I and III-IX may be pursued as minors for the degree of A.M. and Ph.D. by candidates who have not taken such courses in undergraduate work. Three hours per week for one term constitutes a minor for the degree of A.M., and three hours per week for two terms a minor for the degree of Ph.D.

X—ADVANCED THEORETICAL MECHANICS—General principles of statics and kinetics; methods of Lagrange, Hamilton, and Jacobi; application of the doctrine of energy to the interpretation of mechanical phenomena. Lectures, 2 hours, first and second term. Professor WOODWARD

XI—THEORY OF THE POTENTIAL FUNCTION—General exposition of theory; derivation of equations of Laplace and Poisson, and theorems of Gauss, Green, and Stokes; with applications to problems in gravitation, hydromechanics, static electricity, and terrestrial magnetism. Lectures, 2 hours, first and second term. Professor WOODWARD

XII—GEODYNAMICS—Amount and distribution of earth's mass ; phenomena of precession, nutation, and oceanic tides ; variation of density, gravity, and pressure within the earth ; thermal properties, and secular contraction ; mechanics of crumpling and crust movements. Lectures, 2 hours, first and second term. Professor WOODWARD

XIII—MATHEMATICAL THEORY OF ELASTICITY—Analysis of stresses and strains and expression of strains in terms of stresses ; discussion of potential energy of strained media and the constants essential to define them ; theory of wave motion in elastic media, with applications to sound and light. Lectures, 2 hours, first and second term. Professor WOODWARD

XIV—MAXWELL'S THEORY OF ELECTRICITY AND MAGNETISM—Lectures, 2 hours, first and second term. Professor PUPIN

XIVA—THEORY OF BESSEL'S FUNCTIONS AND SPHERICAL HARMONICS—Lectures, 1 hour, first and second term. Professor PUPIN

XV—ELECTROMAGNETIC THEORY OF LIGHT—Lectures, 3 hours, first term. Professor PUPIN

XVI—ADVANCED THERMODYNAMICS, including its applications to thermoelectricity and thermo-magnetism, physical chemistry, and caloric engines.—Lectures, 2 hours, first and second term. Professor PUPIN

XVII—ADVANCED THEORETICAL ELECTRICAL ENGINEERING, consisting of a discussion of the practical aspects of high frequency and high potential currents ; theory of the telephone ; theory of transmission of signals through cables possessing considerable distributed capacity ; theory of long-distance transmission of power by direct, alternating, and polyphase currents ; conduction of currents through gases and dielectrics.—Lectures, 3 hours, second term. Professor PUPIN

XVIII—THEORY OF OSCILLATIONS—2 hours. Professor PUPIN

NOTE—Time equivalent to three hours per week for four terms devoted to Courses X to XVIII is required as a major for the degree of Ph.D., and three hours per week for two terms as a major for the degree of A.M. For a minor for the degree of Ph.D., a time equivalent to two hours per week for two terms is required.

Department of Physics

Collegiate Courses

I—GENERAL PHYSICS—Sound and Heat (first term). Light and Electricity (second term). Lectures and recitations, 3 hours per week. Professor ROOD and Mr. GORDON

Required of first-year students in the School of Mines, except those in the course of Architecture. Open to Seniors, in the College.

University Courses

II—SOUND (first term) ; MAGNETISM AND ELECTRICITY (second term)—2 hours lectures, 2 or 6 hours laboratory work. Text-books : Atkinson's *Ganot*, and Stewart and Gee's *Physics*. Professor ROOD

Open to Juniors and Seniors, of the College, and to candidates for the degree of A.M. whose minor subject is *Physics*.

III—ELECTRICITY (first term)—Lectures on absolute system of mechanical and electrical units; electrical measurements; the derivation and use of the Ampere, Volt, Ohm, Watt, and Joule.

EXACT ELECTRICAL MEASUREMENTS (second term)—Lectures on the Farad, Coulomb, and units of electric and magnetic induction; electrical and magnetic measurements in the laboratory. 2 hours lectures, 8 hours laboratory. Text-books: Everett's, C. G. S., System of Units, Glazebrook and Shaw's Physics, Kohlrausch's Physical Measurements, Wiedemann and Eberts' Physics, and A. Witz's Physics. Professor HALLOCK

Required of second-year students in the Electrical Engineering course. Second-year students in all courses in the School of Mines except Architecture are required to attend the lectures of the first term, and to take 2 hours of laboratory work during both terms. Open to Seniors in the College, and to candidates for the degree of A.M. whose minor subject is Physics. Pre-requisite: I or II with 2 hours laboratory work.

IV—LIGHT (first term)—Lectures on the velocity, reflection, refraction, and dispersion of light. Achromatism, optical instruments, the eye, and Young's theory of color. Physical measurements in the laboratory.

HEAT (second term)—Lectures on the expansion of solids, liquids, and gases; on conduction, specific heat, tension of vapors, and radiant heat. Physical measurements in the laboratory. 3 hours lectures, 2 or 4 hours laboratory. Text-books: Stewart and Gee, and Glazebrook and Shaw's Physics. Professor ROOD

Open to Seniors of the College, and to candidates for the degree of A.M. whose minor subject is Physics.

V—MODES OF CONSTRUCTING AND DESIGNING APPARATUS (first term)—1 hour. Professor HALLOCK

Open to Juniors, Seniors of the College, to second-year students School of Mines, and to University students. Pre-requisite or parallel: Course II, III, or IV.

VI—THE STEAM ENGINE (second term)—1 hour. Mr. GORDON

Open to Juniors and Seniors of the College. Pre-requisite or parallel: Course II or IV.

VII—ELECTRICAL MANIPULATION (first term)—1 hour. THEORETICAL COMPARISON OF ELECTRICAL METHODS (second term)—2 hours. Mr. PARKER

Open to candidates for the degree of Electrical Engineer, to Seniors of the College and to University students. Pre-requisite or parallel: III or IV.

VIII—UNDULATORY THEORY OF LIGHT (second term)—2 hours lectures. Professor HALLOCK

Open to Seniors of the College and to University students. Pre-requisite or parallel: Course IV of 7 hours.

Laboratory Courses

IX—ELECTROMOTIVE FORCE OF STANDARD AND CONSTANT CELLS

X—STUDY OF STRENGTH OF ELECTRIC CURRENTS

XI—STUDY OF ELASTICITY OF SOLID BODIES

XII—COLORIMETRY, AND ABSORPTION SPECTRA

XIII—PHOTOMETRY

Open, with 5 hours laboratory work, to candidates for the degree of A.M., or with 8 hours laboratory work, to candidates for the degree of Ph.D., whose minor subject is Physics. Pre-requisite: Course II of 4 hours.

XIV—CALIBRATION OF WHEATSTONE BRIDGES

XV—HYPSOMETRY

XVI—DETERMINATION OF INDEX OF REFRACTION BY SPECIAL METHODS

XVII—QUANTITATIVE EXAMINATION OF THE DISCHARGE OF THE INDUCTION COIL

XVIII—VISCOSITY OF SOLIDS

Open to candidates for the degree of A.M., or, with 10 hours laboratory work, to candidates for the degree of Ph.D., in their first year, whose major subject is Physics. Pre-requisite: Courses II and IV of 8 and 7 hours.

XIX—GALVANOMETER CONSTRUCTION FOR MAXIMUM EFFICIENCY

XX—ADVANCED COURSE IN SPECTROMETRY

XXI—BALLISTIC-GALVANOMETER WORK, INDUCTANCE

XXII—CALORIMETRY

XXIII—RADIANT HEAT

XXIV—INTERFERENCE OF LIGHT

XXV—POLARIZED LIGHT

XXVI—ACOUSTIC MEASUREMENTS

XXVII—THERMO-ELECTRICITY

XXVIII—MEASUREMENT OF LOW RESISTANCE

XXIX—ELECTRICAL INSULATION

Professors ROOD and HALLOCK, Mr. GORDON, and Mr. PARKER

Open, with 10 hours laboratory work, to candidates for the degree of Ph.D., in their first year, whose major subject is Physics. Pre-requisite: Courses II and IV of 8 and 7 hours.

Original research, conducted under the direction of Professors Rood and Hallock, is open to candidates for the degree of Ph.D., in their second year, whose major subject is Physics.

Department of Chemistry

Collegiate Courses

I—GENERAL INORGANIC CHEMISTRY—Introduction. Laws of Chemical combination, history, occurrence, preparation and properties of the elements and their principal compounds. Text-book: Newth's Inorganic Chemistry. 2 lectures and 1 recitation or 1 laboratory exercise. Professor CHANDLER, Dr. WIECHMANN, and Dr. VULTÉ

Required of all first-year students in the School of Mines except students in the course of Architecture. Open as an elective to Sophomores, Juniors, and Seniors in the College; with two lectures and one afternoon in the laboratory.

II—PHYSICS AND GENERAL CHEMISTRY—Text-books: Ganot's Physics, Barker's Physics, and Newth's Inorganic Chemistry. 4 lectures throughout the year. Professor CHANDLER

Required of first-year students in the School of Medicine. Open as an elective to Seniors in the College.

III—CHEMICAL PHYSICS—Text-books : Wiechmann's Lecture Notes on Theoretical Chemistry ; Wootton's Problems in Chemical Physics and Specific Gravities. Lectures and recitations twice a week during the first session. Dr. WIECHMANN

Required of first-year students in the course of Analytical and Applied Chemistry in the School of Mines. Open as an elective to Seniors in the College.

IV—STOICHIOMETRY—Text-books : Wiechmann's Lecture Notes on Theoretical Chemistry ; Thorpe and Tate's Series of Chemical Problems. Lectures and recitations twice a week during the second session. Dr. WIECHMANN

Required of first-year students in the course of Analytical and Applied Chemistry in the School of Mines. Open as an elective to Seniors in the College.

IX—QUALITATIVE ANALYSIS—Lectures, recitations, and laboratory practice. Text-books : Fresenius' Qualitative Analysis ; Wells and Cushman's Schemes for Qualitative Analysis. 2 lectures, 2 recitations, and laboratory practice of at least 8 hours. Dr. WELLS and Dr. CUSHMAN

Required of first-year students in the School of Mines in the courses of Mining Engineering, Electrical Engineering, Metallurgy, Geology and Palæontology, and Analytical and Applied Chemistry. Open to Seniors in the College. Pre-requisite or parallel: Course I.

University Courses

V—CHEMICAL PHILOSOPHY—Energy and energy-forms, chemical energy, photo-chemistry, thermo-chemistry, electro-chemistry. Text-book : Wiechmann's Lecture Notes on Theoretical Chemistry. Lectures and recitations twice a week throughout the year. Dr. WIECHMANN

Required of second-year students in the course of Analytical and Applied Chemistry in the School of Mines. Minor for the degree of A.M. and Ph.D. Pre-requisite: Courses III and IV.

VI—CHEMICAL PHILOSOPHY, ADVANCED COURSE—History of chemical theory. Study of selected problems in theoretical chemistry. Physico-chemical methods. Lectures, conferences, and recitations 4 hours a week throughout the year. Dr. WIECHMANN

Minor subject for Ph.D. Pre-requisite: Courses III, IV, and V.

VII—PREPARATION OF INORGANIC COMPOUNDS, SHORT COURSE—Laboratory work 5 afternoons and one conference during the last half of the second term. Text-book : Vulté and Neustadt's Laboratory Manual of Inorganic Preparations. Dr. VULTÉ

Required of third-year students in the course of Analytical and Applied Chemistry in the School of Mines.

VIII—PREPARATION OF INORGANIC COMPOUNDS, LONG COURSE—8 hours and one conference. Bender and Erdmann's Chemische Präparatenkunde. Dr. VULTÉ

Open to candidates for the degree of A.M. whose major subject is Chemistry.

X—INVESTIGATION OF NEW METHODS OF QUALITATIVE AND QUANTITATIVE ANALYSIS—Conferences and laboratory practice at least 10 hours. Professor RICKETTS and Dr. WELLS

Open to candidates for the degree of A.M. whose major subject is Chemistry. Pre-requisite: Courses I and IX.

XI—THE SPECTROSCOPE AS APPLIED TO QUALITATIVE AND QUANTITATIVE ANALYSES—Laboratory practice and conference with the instructors, 8 hours. Professor RICKETTS and Dr. WELLS

Open to candidates for the degree of A.M. whose minor subject is Chemistry.

XII—CHEMICAL REACTIONS, QUALITATIVELY AND QUANTITATIVELY CONSIDERED—Conferences and laboratory practice at least 8 hours. Dr. WELLS and Mr. BOWEN

Open to candidates for the degree of A.M. whose major subject is Chemistry.

XIII—QUANTITATIVE ANALYSIS—Text-books: Cairns' Quantitative Analysis and Fresenius' Quantitative Analysis. 2 lectures and 2 recitations and laboratory practice 15 hours throughout the second year and one session of the third year. Professor RICKETTS, Mr. BOWEN, and Dr. VULTÉ

Required of second- and third-year students in the course of Analytical and Applied Chemistry in the School of Mines. Open to candidates for the degree of A.M. whose major subject is Chemistry.

XVII—SPECIAL VOLUMETRIC METHODS OF QUANTITATIVE ANALYSIS—Conferences and laboratory work at least 8 hours. Professor RICKETTS

Open to candidates for the degree of A.M. whose major subject is Chemistry.

XVIII—REVISION OF CONSTANTS EMPLOYED IN PROXIMATE ANALYSES—Conferences and laboratory work at least 12 hours. Professor RICKETTS and Dr. VULTÉ

Open to candidates for the degree of Ph.D. whose major subject is Chemistry.

XIX—SPECIAL METHODS FOR THE ANALYSIS OF PLANTS AND THEIR PRODUCTS—Fibres, starches, sugars, oils. Conferences and laboratory work at least 12 hours. Research. Professor RICKETTS and Dr. VULTÉ

Open to candidates for the degree of Ph.D. whose major subject is Chemistry.

XX—ELECTROLYTIC ANALYSIS, QUALITATIVE AND QUANTITATIVE—Conferences and laboratory work at least 12 hours for 2 years. Research. Professor RICKETTS and Dr. WELLS

Open to candidates for the degree of Ph.D. whose major subject is Chemistry.

XXIV—ORGANIC CHEMISTRY, ELEMENTARY COURSE—Lectures 4 hours a week throughout the year. Text-book: Bernthsen's *Kurzes Lehrbuch der organischen Chemie*. Professor COLBY

Minor for the degree of A.M. Pre-requisite: Courses I, III, IV, V.

XXV—GENERAL ORGANIC CHEMISTRY—Lectures and recitations 6 hours a week, and laboratory practice at least 18 hours a week throughout the year. In this course the subject is fully treated and the student prepares in the laboratory a large number of organic compounds, besides making elementary analyses and molecular weight determinations. Text-books: Bernthsen's *Kurzes Lehrbuch der organischen Chemie*; Levy's *Organische Präparate*; Gattermann's *Praxis der organischen Chemikers*. Professor COLBY and Mr. BOGERT

Required of fourth-year students in the course of Analytical and Applied Chemistry in the School of Mines.

Major for the degree of A.M. Pre-requisite: Courses I, III, V, VIII, IX, and XIII.

XXVI—ADVANCED ORGANIC CHEMISTRY, MINOR COURSES—Any one of the following subjects: (1) Studies in thermo-chemistry; (2) Physical properties of organic compounds as related to their molecular constitution; (3) Dissociation coefficients of organic acids; (4) Chemical dynamics; (5) The terpenes and camphors; (6) Synthetic alkaloids; and such other subjects as may be selected. Personal instruction and laboratory work not less than 12 hours a week. Professor COLBY and Mr. BOGERT

Minor for the degree of Ph.D. Pre-requisite: Course XXV.

XXVII—ADVANCED ORGANIC CHEMISTRY, MAJOR COURSE—Original investigation and research. Subject to be assigned or approved by the professor. Personal instruction, conferences, private study, and laboratory work. No definite number of hours a week. Professor COLBY and Mr. BOGERT

Major for the degree of Ph.D. Pre-requisite: Course XXV.

XXVIII—PHYSIOLOGICAL CHEMISTRY—Including the preparation and properties of the chief constituents of plants and animals. Text-book: Pellew's Manual of Medical and Physiological Chemistry. This course is given twice a year, and consists of 2 lectures and 2 afternoons in the laboratory for one term. Mr. PELLEW and Mr. TUCKER

Required of first-year students in the School of Medicine. Open as an elective to Seniors in the College. Open to candidates for the degree of A.M. whose minor subject is Chemistry.

XL—TOXICOLOGY—The preparation and detection of the more important mineral and vegetable poisons. Fifteen weekly lectures and fourteen laboratory exercises of 2 hours each. The course is given twice during the year, the class being divided into four sections, two of which pursue the subject during the first session, the other two sections during the second session. Mr. PELLEW and Mr. JOHNSON

Open to candidates for A.M. as a minor. Required of second-year students in the School of Medicine.

Department of Mineralogy

Collegiate Courses

I—BLOWPIPE ANALYSIS—The tests for 40 elements and the qualitative analysis of minerals, alloys, and slags. 1 hour per week conference, and afternoons of alternate weeks laboratory, 1 term. Professor MOSES, Dr. LUQUER, and Mr. WHITLOCK

Required of first-year students in the School of Mines in the courses of Mining Engineering, Chemistry, Metallurgy, and Geology. Open as an elective to Seniors in the College.

II—CRYSTALLOGRAPHY—History, general characters, laws, forms, simple measurements, and calculations. Lectures and conferences 2 hours, 1 term. Professor MOSES

Required of first-year students in the School of Mines in the courses of Mining Engineering, Chemistry, Metallurgy, and Geology. Open as an elective to Seniors in the College.

V—ELEMENTARY COURSE ON TWENTY-FIVE COMMON MINERALS—12 lectures in first term of third year as introduction to study of geology. Professor MOSES

Required of third-year students in the School of Mines in the course of Architecture.

VI—OPTICAL MINERALOGY—Introductory to Geology V. 2 lectures and 1 afternoon for two months of second term of second year. Dr. LUQUER

Required of second-year students in the School of Mines in the courses of Mining Engineering, Metallurgy, and Geology.

University Courses

III—DESCRIPTIVE AND DETERMINATIVE MINERALOGY—Study of 200 important species, their properties, uses, and methods of determination. 2 hours lectures, 3 hours laboratory, second term of first year and first term of second year. Professor MOSES and Dr. LUQUER

Required of first- and second-year students in the School of Mines, in the courses of Mining Engineering, Chemistry, Metallurgy, and Geology. Open to candidates for the degree of A.M., or for the degree of Ph.D., in their first year, whose minor subject is Mineralogy. Pre-requisite: Courses I and II.

IV—THE MINERALS OF BUILDING-STONES—Study of 70 species, their properties, methods of determination, and their economic effect on building-stones. 2 hours lectures, 2 hours laboratory. Professor MOSES and Dr. LUQUER

Required of second-year students in the School of Mines in the course of Civil Engineering. Open to candidates for the degree of A.M. whose minor subject is Mineralogy.

VII—MATHEMATICAL CRYSTALLOGRAPHY—Measurement of angles of crystals, methods of calculation and delineation. Professor MOSES

Required of third-year students of the School of Mines in the course of Geology. Open to candidates for the degree of A.M. whose major subject is Mineralogy, or candidates for the degree of Ph.D. whose minor subject is Mineralogy. Pre-requisite: Course II.

VIII—OPTICAL MINERALOGY—Principles, apparatus, and distinguishing characters. Dr. LUQUER

Required of third-year students in the School of Mines in the course of Geology. Open to candidates for the degree of A.M. whose major subject is Mineralogy, or to candidates for the degree of Ph.D. whose minor subject is Mineralogy. Pre-requisite: Course IV, or equivalent.

IX—MINERALOGY—Supplementary to Course III. Professor MOSES

Open to candidates for the degree of Ph.D. whose minor subject is Mineralogy. Pre-requisite: Courses I, II, III, or equivalent.

X—SYSTEMATIC MINERALOGY—Classification: physical and chemical relations of species and groups; general study of physical properties, with especial attention to measurement, methods of calculation and delineation of crystals; optical characters; and a critical study of some assigned group. 20 hours, two years. Professor MOSES and Dr. LUQUER

Open to candidates for the degree of Ph.D. whose major subject is Mineralogy. Pre-requisite: Courses I, II, III, VI, or equivalent.

Department of Astronomy

Collegiate Courses

I—GENERAL ASTRONOMY—This course is historical and descriptive, and is supplemented by visits to the observatory, where students are taught to locate the principal constellations, and are afforded opportunities to view the sun, moon, planets, nebulae, and stars. Reference books: Young's General Astronomy, Grant's History of Physical Astronomy, Clerke's History of Astronomy during XIX Century, and Clerke's System of the Stars. 2 hours. Professor REES, assisted in the observatory by Dr. DAVIS

Elective for Seniors and Juniors in the College.

II—SPHERICAL AND PRACTICAL ASTRONOMY—This course consists mainly of the study and use of the sextant for time and latitude determinations, and of the transit instrument for time. Reference book; Hand-book of Practical Astronomy by W. W. Campbell. 2 hours lectures and 2 hours observatory work. Professor REES and Dr. DAVIS

Elective for Seniors in the College. Offered as a minor for the degree of A.M.

III—GEODESY—This course deals with the subjects named in the scheme of the summer school in geodesy, During the vacation between the first and second years of this course, the students are required to attend the summer school for six weeks to learn the use of apparatus, as indicated by the following:

- (1) Use of the nautical almanac and American ephemeris
- (2) Sextant observations for time and latitude
- (3) Transit instrument for time
- (4) Base-line measurements
- (5) Angle measurements by "directions"
- (6) Determination of the azimuth of a line
- (7) Barometric hypsometry

Reference books: Campbell's Practical Astronomy, Clark's Geodesy, United States Coast Survey Reports, and Jordan's Handbuch der Vermessungskunde. 2 hours lectures first year and first term of second year. Professor REES, Professor JACOBY and Dr. DAVIS

Required in the Civil Engineering course of School of Mines during third and fourth years. The third-year work is offered as a minor for the degree of A.M. The fourth year, including summer-school work, is offered as a major for the degree of A.M.

University Courses

IV—ADVANCED SPHERICAL AND PRACTICAL ASTRONOMY—This course deals with the subjects of time, latitude, and longitude; use of equatorial and of zenith telescopes. Reference books: Chauvenet's (two vols.) Spherical and Practical Astronomy, and Doolittle's Practical Astronomy. 2 hours lectures and 4 hours observatory work for two years. Professor REES and Professor JACOBY

First year offered as a major for the degree of A.M. or a minor for the degree of Ph.D. Two years' work offered as a major for the degree of Ph.D.

V—THEORETICAL ASTRONOMY—This course deals mainly with the theory of comet orbits and their calculation. Reference books: Klinkerfues' *Theoretische Astronomie* and Oppolzer's *Bahnbestimmung*. 1 hour, supplemented by computations, for 2 years. Professor JACOBY

First year offered as a major for the degree of A.M. or a minor for the degree of Ph.D.
Two years' work offered as a major for the degree of Ph.D.

! VI—THEORY AND METHODS OF REDUCTION OF PHOTOGRAPHIC STAR PLATES—This course deals with the determination of star places from the photographic plates, and includes the subjects of stellar parallax and proper motion. 1 hour, with practical work, for 2 years. Professor JACOBY

First year offered as a major for the degree of A.M. or a minor for the degree of Ph.D.
Two years' work offered as a major for the degree of Ph.D.

Department of Geology

Collegiate Courses

I—GENERAL GEOLOGY—First term, physical geology, with practical work in the rock collections under the lithological part of the subject; second term, stratigraphical and historical geology, involving laboratory work with type fossils and collections illustrating the geology of the United States. Text-books: Le Conte's *Elements of Geology* and Dana's *Manual of Geology*. 2 hours lectures, including laboratory work. Mr. HOLLICK

Elective to Juniors and Seniors in the College.

II—GENERAL GEOLOGY—A more elaborate discussion of the subjects treated in Course I. Text-book: Le Conte's *Elements of Geology*, and Dana's *Manual of Geology*. 3 hours lectures, including laboratory work. Professor KEMP

Elective to Seniors in the College who have not taken Course I.

University Courses

III—ECONOMIC GEOLOGY—First term, a discussion of the general features and formation of ore bodies, followed by a description of the deposits of the ores of iron, copper, lead, zinc, silver, gold, and the lesser metals, with especial reference to North America; second term, a description of the distribution and occurrence of coal, petroleum, natural gas, asphalt, building-stone, water supply, salines and minor minerals. Text-book: Kemp's *Ore Deposits of the United States*, and lecture notes privately printed. 3 hours lectures and conferences. Professor KEMP

Required of all fourth-year students of the School of Mines in the courses of Mining, Metallurgy, Chemistry, and Geology. That portion of the course relating to building-stones is required of fourth-year students in the course in Architecture. Elective for Seniors in the College who have had Course I or II, or an equivalent. Open with two additional hours weekly of collateral reading to candidates for the degrees of A.M. and Ph.D., whose minor subject is Geology.

VI—PETROLOGY—A discussion of the microscopic structure, mineralogical composition and genetic relations of the igneous and metamorphic rocks. Pre-requisite: Optical Mineralogy. 2 hours lectures, 4 hours laboratory or more. Professor KEMP

Required of fourth-year students in the course in Geology. Open to candidates for the degrees of A.M. and Ph.D. whose major or minor subject is Geology. Given in alternate years with Course VIII. Not offered in 1896-7.

VII—INVERTEBRATE PALÆONTOLOGY—A general description of invertebrate fossils, following the biological sequence. Pre-requisite: Course I, Department of Zoölogy. Text-books: Zittel's *Handbuch der Palæontologie*, vol. i. and Nicholson's *Manual of Palæontology*. 2 hours lectures, 4 hours laboratory. Mr. VAN INGEN

Required of fourth-year students in the course in Geology. Open to candidates for the degrees of A.M. and Ph.D. whose major or minor subject is Geology. Given in alternate years with Course VIII. Not offered in 1896-7.

VIII—COMPARATIVE GEOLOGY—A description and study of the geological formations in their areal distribution and time relations, taking up the various schemes of classification, the character of the rocks, the typical forms of life, and the upheavals and igneous intrusions of each period. Text-books: The *Correlation Bulletins of the U. S. Geological Survey*, Kayser's *Text-book of Comparative Geology*, and the manuals of Dana, Geikie, and De Lapparent. 2 hours lectures, and at least 4 hours laboratory and reading. Professor KEMP for the crystalline rocks, Mr. VAN INGEN for the sedimentary

Major or minor for A.M. or Ph.D. Given in alternate years with Courses VI and VII. Offered in 1896-7.

IX—PALÆOBOTANY—Study of fossil plants, following the biological sequence. Pre-requisite: Course I or II, Department of Botany; Course I or II, Department of Geology. Text-book: Zittel's *Handbuch der Palæontologie*, vol. ii, and Solms-Laubach's *Palæophytology*. 1 hour lecture or conference, 4 hours laboratory or reading for two years. Mr. HOLLICK

Open to candidates for the degrees of A.M. and Ph.D. whose major or minor subject is Geology.

X—As a thesis subject which will furnish a major course for the concluding year of study for the degree of Ph.D. some such subject as the following will be assigned:

(a) Petrography of the Serpentine in the Vicinity of New York; (b) Geology of some restricted area, in Eastern North America; (c) Investigation of some Series of Ore Deposits; (d) Study of the Flora or Fauna of Certain Geological Horizons with field work. The work will be done under the direction of that officer of the department who has given the subject special attention.

Department of Zoölogy

Collegiate Courses

I—ELEMENTARY ZOÖLOGY—Introductory to Elementary Biology—Palæontology—Geology. (1)—Outline of the rise of Natural History; living authors. (2)—Cellular basis and simple functions of life—Branches of Biology—Prin-

ciples of Zoölogical Classification. (3)—Systematic and descriptive course : Protozoöns, Sponges, Cœlenterates, Echinoderms, Vermes, Arthropods, Molluscs, Molluscoids, Vertebrates : Fishes, Reptiles, Birds, Mammals. (4)—Influence of living organisms upon the earth's surface. (5)—General principles, distribution, environment, evolution. Text-book : Packard's Elements of Zoölogy. Dr. DEAN

Open to School of Mines students, one year, 1 hour a week. Lectures and demonstrations in the museum.

II—ELEMENTARY BIOLOGY—Introductory to Morphology, and Physiology, and to the General Principles of Biology. (1)—General Introduction : Protoplasm and the cell. Biology of the Earth-worm and the Fern—Unicellular organisms : Amoeba, Pleurococcus, Yeast, Bacteria, Infusoria—Transitional organisms : Spirogyra, Nitella—Multicellular organisms : Hydra, Hydroids. (2)—Introduction to Invertebrate Zoölogy—Earth-worm, lobster, crab, grasshopper, mussel, starfish. (3)—Introduction to Vertebrate Zoölogy—The lancelet, dogfish, rabbit, pigeon, and embryonic development of the bird (chick). In this course the detailed study of a series of living forms is made the basis for brief discussions of the leading principles of general Biology. In addition the main problems of Evolution, Heredity, and the like are briefly explained. 2 afternoons (4 hours) a week throughout the year. Text-books : Sedgwick and Wilson, General Biology ; Marshall and Hurst's Practical Zoölogy ; Osborn's Greeks to Darwin. Reference books : Parker's Elementary Biology ; Thomson's Zoölogy. Professor WILSON, Professor OSBORN

Open to Juniors, elective. Lectures and laboratory work. This course is designed for students of Geology, Psychology, Physiology, and Medicine, as well as for those who intend to pursue Botany or Zoölogy.

III—GENERAL ZOÖLOGY—An introduction to more advanced Zoölogy, Ætiology, Morphology, and Embryology. (1)—Natural environment, faunal areas, terrestrial and marine—Principles of faunal distribution—Geological succession of life, or Palingenesis. (2)—Classification and Comparative Anatomy of the main vertebrate types, fishes, amphibians, reptiles, birds, and mammals—Comparative study of nervous, vascular, alimentary systems, etc.—Embryology : the development of the bird, amphibian, fish. Embryological technique. (3)—Comparative Morphology, Classification and General Zoölogy of Invertebrates. Text-books : Open to Seniors, elective. Wiedersheim's Comparative Anatomy ; Hertwig's Zoölogy ; Foster and Balfour's Elements of Embryology. Professor OSBORN, Professor WILSON

2 afternoons (4 hours) a week throughout the year. Lectures and laboratory work. This course is especially designed for students preparing for Medicine, for students of Palæontology, and for those who intend to pursue Zoölogy.

IV—COMPARATIVE NEUROLOGY—An introduction to the comparative structure of the brain and nervous system of the lower and higher animals. The invertebrate nervous system is broadly treated as throwing light upon general neurological questions as to the origin and structure of the nervous system. The vertebrate nervous system is studied more in detail as also leading to a better comprehension of the nervous system of man. Primitive vertebrate system in

the lancelet—Comparative Anatomy of the brain, spinal cord, and nerves in fishes, amphibians, reptiles, birds, and mammals—Training in Weigert, Golgi, and other technical methods. Text-book : Edinger's Twelve Lectures upon the Nervous System ; also the works of Golgi, Cajal, Obersteiner, Lenhossék, and others. Dr. STRONG

Open to advanced Seniors and Graduates. Seniors, 1 morning (3 hours) a week throughout the year. Graduates, 1 day a week. Lectures and laboratory work throughout the year.

University Courses

V—COMPARATIVE ZOÖLOGY—General Anatomy and Development of Vertebrates and Invertebrates, with special reference to the problems of Phylogeny and Classification—Training in anatomical and embryological technique. Lectures and laboratory work. 6 hours (1 day) a week. This course completes the general systematic and morphological training begun in Courses II and III. Wiedersheim's *Grundriss der Vergleichenden Anatomie der Wirbelthiere*, Parker's *Zoöatomy*, McMurrich's *Invertebrate Morphology* ; Lang's *Comparative Anatomy*. Professor OSBORN, Professor WILSON

Required of all candidates for A.M. and Ph.D. Two days as a major.

VI—COMPARATIVE EMBRYOLOGY—A general comparative treatment of the earlier stages of development, with especial reference to vertebrates. 6 hours (1 day) a week through the first half-year (parallel with Course V). Foster and Balfour's *Elements* ; Marshall's *Embryology*. Professor WILSON

Required of all candidates for Ph.D. Two days as a major.

VII—CELLULAR BIOLOGY—General structure and functions of the cell. 6 hours (1 day) a week through the second half-year (parallel with Course XII). Hertwig, *Zelle und Gewebe* ; Wilson's *Cell*. Professor WILSON

VIII—MORPHOLOGY OF THE MAMMALS—A study of the structure and development of fossil and recent mammals. Lecture and laboratory courses. Reference books : Flower's *Osteology* ; Flower and Lydekker, *Mammals* ; Zittel's *Palæontologie*. 6 hours (1 day) a week. Professor OSBORN

IX—MORPHOLOGY OF THE FISHES—The comparative anatomy of the fishes, recent and fossil. Lecture and laboratory course in second term. Reference book : Smith Woodward's *Catalogue of Fossil Fishes*. 6 hours (1 day). Dr. DEAN

Open to School of Mines students in certain courses.

IXA—EMBRYOLOGY OF THE FISHES—A lecture course on the development of the lower Vertebrates, Amphioxus to Amphibian. Text-Book : Dean's *Fishes*. 1 lecture a week during second term. Dr. DEAN

To be given in alternate years in place of Course IX.

X—SPECIAL MORPHOLOGY—The Protozoa. A general treatment of the classification, morphology, and physiology of this type of organisms, and of their relations to modern theories of biology. 1 lecture a week during second term. Bütschli, *Protozoa in Bronn's Thierreich*. Mr. CALKINS

XI—ADVANCED BIOLOGY—Study of special groups of animals or of special biological problems as an introduction to original investigation. 12 hours (2 days).

XII—SPECIAL AND EXPERIMENTAL EMBRYOLOGY—Critical treatment of the problems of cleavage, germ-layers, differentiation, and the general interpretation of development. 1 lecture a week through the second half-year (parallel with Course VII). Mark-Hertwig; Korschelt and Heider. Professor WILSON

XIII—VERTEBRATE ORGANOGENY—The development of the principal vertebrate organs, brain, heart, alimentary and respiratory systems, skeleton of the head, trunk, and limbs. Bearing upon problems of vertebrate phylogeny. This course is given in second term, alternating with V in 1893-4 and in 1895-6. Open to graduates. Lecture and 4 hours laboratory work. Professor. OSBORN, Dr. DEAN

Courses VII-XIII are offered as partial major or minor requirements for Ph.D.

JOURNAL CLUB—Wednesday 12-1 P.M. Reports upon recent researches in various branches of Vertebrate and Invertebrate Embryology and Morphology, Cytology and Neurology.

BIOLOGICAL SEMINAR—Informal discussion and criticism of biological theories in connection with the history of Zoölogy. Conducted by Professor OSBORN, officers of the department, and graduate students. Wednesday 4.30-5.30 P.M.

ZOÖLOGICAL CONFERENCES—Evening meetings for discussions of marine faunas and methods of collecting and preservation, preparatory to the summer expedition. Conducted by students and junior members of the department.

Department of Botany

Collegiate Courses

I—ELEMENTARY BOTANY, LONGER COURSE—Study of botany in its broadest sense, including introduction, vegetable anatomy, vegetable physiology, systematic botany in the biological sequence of the groups, morphology of the flowering plants, and a review of palæobotany. Text-book: to be assigned. 1 hour lecture and 4 hours (2 afternoons) laboratory work. Professor BRITTON and Dr. CURTIS

II—ELEMENTARY BOTANY, SHORTER COURSE—Covering the same ground as Course I. Text-book: to be assigned. 1 hour lecture and 2 hours (1 afternoon) laboratory work. Professor BRITTON and Dr. CURTIS

III—GENERAL BOTANY—Description of the principal features of vegetable physiology and anatomy, and of the principal characteristics of the sub-kingdoms and classes. 1 hour lecture. Professor BRITTON

Required of first-year students in the School of Mines in Chemistry, Mining Engineering, Civil Engineering, and Geology.

Open to Seniors in the College.

IV—PLANT ANATOMY AND PHYSIOLOGY—Study of the principal characteristics of vegetable cells and tissues. Text-book: Goodale's *Physiological Botany*. Pre-requisite: Courses I or II, or their equivalent. 4 hours laboratory work. Dr. CURTIS

V—MORPHOLOGY AND DETERMINATION OF THE FLOWERING PLANTS—Dissection and examination of not less than one hundred species of flowering plants selected by the professor, followed by a systematic study of types of the natural orders taken in biological sequence. Text-books: Gray's *Structural Botany* and *Manual of Botany*. Pre-requisite: Courses I or II, or their equivalent. 4 hours laboratory work. Professor BRITTON

VI—ECONOMIC BOTANY—Description of drug-plants, food-plants, fibre-plants, and timber-trees, and other plants of economic importance and their products. Pre-requisite: Courses I, II, or III, or their equivalent. 1 hour. Professor BRITTON

University Courses

VII—CRYPTOGAMIC BOTANY—Study of the classes and principal orders of Thallophyta, Bryophyta, and Pteridophyta, with examination of types selected by the professor. Text-books: Bennett and Murray's *Cryptogamic Botany*; Vine's *Text-Book of Botany*. Pre-requisite: Course I or II, or their equivalent. 1 hour lecture or conference and 4 hours laboratory work. Professor BRITTON and Dr. CURTIS

Offered as a minor for degree of A.M.

VIII—ADVANCED PLANT ANATOMY—Critical study of the cells and tissues of some plants selected. Text-book: De Bary's *Comparative Anatomy of Phanerogams and Ferns*. Pre-requisite: Course IV or its equivalent. At least 4 hours laboratory work. Dr. CURTIS

Offered as a minor for the degree of A.M.

IX—THE NATURAL FAMILIES OF FLOWERING PLANTS—Study of the diagnostic characters of the orders in biological sequence. Reference books: Engler and Prantl's *Natürliche Pflanzenfamilien* and Baillon's *Histoire des Plantes*. Pre-requisite: Course V. 1 hour conference and 4 hours laboratory work. Professor BRITTON

Offered as a major for the degree of A.M.

X—ADVANCED CRYPTOGAMIC BOTANY—Supplementary to Course VII. 1 hour lecture or conference and 4 hours laboratory work. Professor BRITTON and Dr. CURTIS

Offered as a major for the degree of A.M.

XI—COMPARATIVE STUDY OF THE TISSUES OF NOT LESS THAN TEN SPECIES OF PLANTS OF THE SAME GENUS OR FAMILY—Not less than 8 hours laboratory work. Research. Professor BRITTON and Dr. CURTIS

Offered as a major for the degree of Ph.D.

XII—COLLECTION, DETERMINATION, AND COMPARATIVE STUDY OF THE PLANTS OF SOME RESTRICTED AREA—Field, herbarium, and laboratory work. Not less than 8 hours for 2 years; field-work during 2 summers. Research. Professor BRITTON

Offered as a major for the degree of Ph.D.

XIII—CRITICAL STUDY OF A FAMILY OR GENUS OF PLANTS OF NOT LESS THAN FIFTY SPECIES—Field, herbarium, and laboratory work. Not less than 8 hours for 2 years. Research. Professor BRITTON

Offered as a major for the degree of Ph.D.

NOTE—Any two of Courses VII, VIII, IX, or X may be taken as a minor for the degree of Ph.D.

Department of Physiology

I—GENERAL PHYSIOLOGY—Structure of protoplasm ; physiology of the cell ; physiological division of labor and evolution of special functions ; irritability ; contractility ; heliotropism ; geotropism ; chemotropism : general principles of secretion ; the nerve cell ; the nerve impulse ; reflex action ; the germ cells. Lectures. 1 hour. Professor LEE

Opened to qualified candidates for the degree of M.D.

Open as elective to Seniors who have had at least one year of General Biology, and, in conjunction with Course III, to such Seniors and to qualified candidates for the degree of A.M. or of Ph.D.

II—THE PHYSIOLOGY OF MAN AS RELATED TO THAT OF OTHER MAMMALS AND OF LOWER VERTEBRATES—Lectures and demonstrations, 4 to 6 hours. This course treats of different portions of its subject in alternate years, certain introductory lectures only being repeated annually. Professors CURTIS and LEE and Dr. CUNNINGHAM

Required, in the first and second years, of candidates for the degree of M.D.

Open as an elective to Seniors in the College, and, in conjunction with Course IV, to qualified candidates for the degree of A.M. or of Ph.D.

III—LABORATORY COURSES IN GENERAL PHYSIOLOGY—5 hours. Professor LEE

Open to qualified candidates for the degree of M.D., and, in conjunction with Course I, to Seniors who have had at least one year of General Biology, and to qualified candidates for the degree of A.M. or of Ph.D.

IV—LABORATORY COURSES—Personal instruction, private reading, practical work, and research. No definite number of hours. Professors CURTIS and LEE and Dr. CUNNINGHAM

Open to qualified candidates for the degree of M.D., and to qualified candidates for the degree of A.M. or of Ph.D.

Research

V—THE LABORATORY is open for research, under the direction of its officers, to advanced workers. Professors CURTIS and LEE and Dr. CUNNINGHAM

Marine Laboratory

An investigator's room at the Marine Biological Laboratory at Wood's Holl, Mass., has been provided by the University for the use of the Department of Physiology.

This renders possible, during the summer, researches upon the physiology of the marine fauna.

Department of Anatomy

[HUMAN AND COMPARATIVE]

Collegiate Courses

II—DEMONSTRATIONS TO SECTIONS OF THE CLASS—Cranial osteology and syndesmology—Myology, angiology, and peripheral nervous system of the head and neck. 1 hour a week throughout the academic year. Dr. SANDS

Required, in the first year, of candidates for the degree of M.D. *in the four-years' course*. Elective for Seniors in the College, in conjunction with III, IV, and V.

III—DEMONSTRATIONS TO SECTIONS OF THE CLASS—Osteology, syndesmology, myology, and angiology of the extremities—The peripheral nervous system. 2 hours a week throughout the academic year. Dr. BROCKWAY

Required, in the first year, of candidates for the degree of M.D. *in the four-years' course*. Elective for Seniors in the College, in conjunction with II, IV, and V.

¶ These courses are so arranged as to maintain, with reference to the subjects treated, a direct connection with the laboratory course in dissection, No. V.

IV—DEMONSTRATIONS TO SECTIONS OF THE CLASS—Preliminary visceral course—Anatomy of the viscera and body cavities. 1 hour a week throughout the academic year.

This portion of the course is designed to afford that general instruction in the descriptive anatomy and the relations of the viscera which is indispensable for the understanding of the courses in the normal histology and physiology of the viscera. Dr. BREWER

Required, in the first year, of candidates for the degree of M.D. *in the four-years' course*. Elective for Seniors in the College, in conjunction with II, III, and V.

V—LABORATORY COURSE—Dissection of a human body. 18 to 20 hours a week, at various hours, for from 3 to 5 periods of 4 weeks each. Professor HUNTINGTON, Dr. GALLAUDET, and the ASSISTANT DEMONSTRATORS OF ANATOMY.

Required, in the first year, of candidates for the degree of M.D. *in the four-years' course*. Elective for Seniors in the College, in conjunction with II, III, and IV.

University Courses

IX—LABORATORY COURSES IN ANIMAL MORPHOLOGY—No specified number of hours a week. Professor HUNTINGTON

Optional, for qualified candidates for the degree of M.D. Open as major or minor courses to candidates for the degree of A.M. or of Ph.D.

X—THE LABORATORY OF ANIMAL MORPHOLOGY is open for research, under the direction of the professor, to advanced workers. No definite number of hours a week. Professor HUNTINGTON

XI—COMPARATIVE MORPHOLOGY OF THE CARPUS—A comparative study of the carpus in vertebrates above fishes, with especial reference to the homologies of the components, their evolution and significance, and their mutual relations in amphibia, reptiles, birds, and mammals

XII—COMPARATIVE MORPHOLOGY OF THE RESPIRATORY APPARATUS, in Mammalia, Sauropsida, and Batrachia—Evolution of the composite mammalian lung from the air-sac—Morphology of mammalian branchial tree—Construction

of terminal branches and end spaces—Skeletal and other modifications of the respiratory apparatus in birds

XIII—COMPARATIVE MORPHOLOGY OF THE CENTRAL NERVOUS SYSTEM—
Demonstration and laboratory course—Detailed work in brain of cod, frog,
turtle, bird, and mammal

XIV—COMPARATIVE MYOLOGY

- (a) Appendicular muscles
- (b) Ventro-appendicular muscles
- (c) Muscles of the foot

XV—HUMAN AND COMPARATIVE MORPHOLOGY OF THE AUDITORY
APPARATUS

XVI—COMPARATIVE MORPHOLOGY OF THE UPPER RESPIRATORY PASSAGES,
NARES, LARYNX, EPIGLOTTIS, SYRINX

XVII—COMPARATIVE MORPHOLOGY OF THE URINO-GENITAL SYSTEM

XVIII—CRANIAL TOPOGRAPHY

In all elective courses offered in morphology the work is designed to be laboratory exercises of at least two continuous hours' duration, at any one exercise, supplemented in certain courses by demonstration and study of material contained in the Museum of Human and Comparative Anatomy and in the study collections of the department.

Department of Bacteriology

University Courses

II—METHODS OF PREPARATION, STAINING, MICROSCOPIC STUDY, MEASUREMENTS, ETC., OF BACTERIA—Preparation of culture media ; study and record of observations of selected typical species ; systematic analyses for determination of unknown species ; methods of isolation of species ; qualitative and quantitative biological examinations of water, soil, and air ; methods of determining pathogenic properties, disinfection, modes of testing value of germicides. Dr. CHEESMAN

Minor for degree of A.M. or of Ph.D.

III—As under Course II, with additional study and determination of known species of bacteria ; special study of the chemical products formed in the growth of bacteria, practical work in photo-micrography, and the pursuit of some selected theme for original investigation. Professor PRUDEN and Dr. CHEESMAN

Major for degree of A.M. or of Ph.D.

LABORATORIES

The Physical Laboratory

The Physical Laboratory consists of six rooms devoted to physical measurements ; some are arranged and used for optical and electrical purposes, others for special researches. The laboratory throughout is supplied with the street current of the Edison incandescent system, and all the ordinary conveniences. Among the pieces of apparatus the following may be specially mentioned :

For measurements of length there are three linear and three circular dividing engines of various designs ; a Geneva Society comparator, and dividing engine ; a Grunow cathetometer, spherometers, an optical lever, and micrometers of many kinds. For measurements of mass there are provided eight balances with weights, specific-gravity apparatus, hydrometers, areometers, Westfall and Jolly balances, and the various forms of vapor density apparatus.

Standard mercurial barometers, aneroid and Mariotti barometers, Kater's and Borda's pendulums, and apparatus for studying elasticity, are provided.

Also a monochord, Quincke's apparatus, Kundt's dust-figure apparatus, and sets of organ pipes and tuning-forks for the study of sound.

Thermometers and apparatus for their calibration, and zero and boiling points, are supplied ; also there is apparatus for determination of coefficients of expansion, for latent and specific heat, and calorimetry.

The optical rooms are furnished with eight spectrometers of different designs, small telescopes, opera glasses, microscopes, sets of lenses, prisms, and gratings, a goniometer, sextant, optical benches, photometers, saccharimeters, total reflectometers, and apparatus for colorimetry, polarized light, and spectroscopy.

In the rooms devoted to electricity are nine galvanometers of various patterns, high and low resistance, ballistic and damped ; electrometers, magnetometers, rheostats and bridges of all types ; condensers, batteries, keys, arc and incandescent lamps, ammeters and voltmeters, and four standard ohms.

The workshop is furnished with a lathe, planer, grinding head, vises, carpenters' and machinists' bench, and tools for work in metal, wood, and glass.

Advanced students are taught and encouraged to repair, alter, and construct apparatus needed for their special work.

Chemical Laboratories

The Qualitative Laboratory is provided with tables, reagents, and all the necessary facilities to enable each student to become familiar with the reactions of the different metals and salts. The student is required to repeat all the experiments of the course of instruction at his own table in this laboratory. When he has acquired a thorough experimental knowledge of a group of bases, single members of the group, or mixtures, are submitted to him for investigation. He thus proceeds from simple to complex cases, till he is able to determine the composition of the most difficult mixtures. Whenever necessary he uses the spectroscope in his work.

The Quantitative Laboratory is provided with tables, reagents, and all necessary apparatus and instruments to enable the student to actually execute with his own hands quantitative analyses. He first analyzes substances of known composition, such as crystallized salts, that the accuracy of his work may be tested by the comparison of his results with the true percentages. He is then required to make analyses of materials occurring in commerce, or in the application of technical sanitary chemistry, metallurgy, and the like, as ores, fertilizers, and waters.

The Laboratory for General Inorganic Chemistry—A portion of one of the laboratories is set apart for the use of the students pursuing the course, and

they are provided with the apparatus necessary to enable them to repeat all of the simpler experiments in general chemistry, such as the preparation of gases.

Laboratory for the Preparation of Inorganic Compounds—A portion of one of the laboratories is set apart for the use of students pursuing Courses VII and VIII, and is provided with the necessary apparatus and materials.

The Organic Laboratory is especially provided with all necessary apparatus and instruments for the determination of boiling points, melting points, specific gravities, vapor densities, for proximate and elementary analyses, and for the synthetic preparation of organic compounds.

The Laboratory for Medical and Physiological Chemistry at the College of Physicians and Surgeons is fully equipped with apparatus, microscopes, and other instruments.

Astronomical Observatory

The Astronomical Observatory contains a set of portable astronomical instruments: a forty-six-inch transit, by Troughton & Simms; a combined transit and zenith instrument for time and latitude determination; an equatorially mounted refractor of five inches aperture, to which is attached a spectroscope with the dispersive power of twelve flint-glass prisms of fifty-five degrees, by Alvan Clark; also a diffraction spectroscope with grating, by L. M. Rutherford, Esq. A set of comparison apparatus, with electrodes, Plucker's tubes, coils, etc., accompanies the spectroscope. The observatory has purchased recently two Repsold measuring machines.

By the gift of Mr. Rutherford there have been added to the observatory equipment: (1) An equatorial refracting telescope of thirteen inches aperture, supplied with a correcting lens for photographic work; with this instrument belong two micrometers for position measurements. (2) A transit instrument of three inches aperture by Stackpole & Brother. (3) A Dent sidereal clock. (4) A micrometer for measuring photographic plates, and sundry other pieces of apparatus. The observatory has a fine mean-time clock by Howard & Co., also chronographs by Fauth & Co., a personal equation machine, etc. The observatory and instruments are lighted by electricity.

Laboratories of the Mineralogical Department

The work of the students in the college courses and in general mineralogy is performed in the Blowpipe Laboratory, a large room with conference tables and seats for about seventy-five men. In this room are the student collections of crystal models and minerals.

For the more advanced work the department uses a smaller room equipped with section cutters and with tables for microscopic and goniometrical work. The instrumental equipment includes four lithological microscopes, four reflection goniometers, a magnificent Duboscq lantern with numerous attachments, three polariscopes, a specific-gravity balance, and three section-cutters.

Geological Laboratories

The Geological Laboratories occupy the basement and parlor floors of the dwelling-house No. 52 East 49th Street, but some study collections are of neces-

sity kept in the lecture-room and museum. The laboratories contain collections illustrative of the different kinds of rocks, and adapted to conferences in the course of general geology. There is also a much larger series of rocks embracing nearly all the rarer species and structures, which are used for advanced work in microscopic petrography. Parallel series of thin sections are provided for these, as are microscopes and other necessary apparatus for study, instruction, and investigation. A machine for grinding thin sections of rock, a photographic laboratory, and drawing facilities, are at hand.

There are study collections accessible to the students which illustrate the various geological formations and type fossils, and which are used in the lectures and conferences on stratigraphical and historical geology. Still others are similarly employed in the lectures on economic geology. The library of the late Professor Newberry is deposited with the department, and affords a quite complete series of geological reports and books of reference. In all the courses a large and continually increasing series of lantern slides is employed in an electric lantern.

SUMMER SCHOOL.

The Trustees of the University have made an appropriation for a Summer School in Geology, which defrays the expenses of a small squad of advanced students for about one month each summer, with the professor of geology. During the college year excursions are offered to points of geological interest near New York, on all Saturdays and holidays of the fall and spring. Few other localities afford so extensive and so accessible exposures as the vicinity of New York.

Zoölogical Laboratory

Pending the construction of the Permanent Zoölogical Laboratory on the new university site, a thoroughly equipped laboratory has been arranged on the third floor of the northern wing of the College of Physicians and Surgeons (West 59th Street), including general and advanced laboratories, museums, aquaria, lecture-room, library, and reading-room. The equipment includes the best Zeiss microscopes, the higher apochromatic objectives, optical instruments, Leitz dissecting stands, and other apparatus for advanced morphological work. The teaching collections include a large series of the Naples marine types, a full set of standard and specially prepared charts, and a variety of living animals and plants contained in fresh-water and marine aquaria.

The department library, a part of the University library kept in the laboratory, the gift of Charles H. Senff, is a memorial to the late Dr. Northrop.

Botanical Laboratory

The Botanical Laboratory is situated on the upper floor of the School of Mines laboratory building. It is fitted up with tables and cases, and is equipped with compound and dissecting microscopes and accessories and other apparatus for study and investigation. There is a large collection of microscopic preparations. The courses of instruction are illustrated by extensive series of models, charts, and lantern slides.

Physiological Laboratory

The Department of Physiology possesses :

(1) The main laboratory, for research and the preparing of demonstrations, covering 1769 square feet and lighted on three sides.

(2) Two rooms for optical or psychological work or for photography, communicating with the main laboratory and with one another. One of these has a free southerly exposure for the heliostat.

(3) The Swift Physiological Cabinet, for the accommodation of a specially endowed and very full collection of apparatus of precision, mainly for research.

(4) Three smaller laboratories, for the officers of the department and for practical classes.

(5) Easy access to a large lecture-room, specially fitted for experimental teaching ; and to a demonstration-room for small classes.

The physiological journals in English, German, and French are accessible at the laboratory to advanced students ; also the most important monographs and other books both modern and ancient.

A skilled mechanic is employed to devote his entire working time, at the laboratory, to the care and improvement of the plant, including the making, altering, and repairing of special apparatus. He also assists in the scientific manipulations.

The following machines and apparatus deserve mention :

An upright seven-horse-power steam-engine, mounted against a pier upon an iron bracket, to avoid floor-vibrations, and working a shaft which runs the whole length of the main laboratory ; two steam lathes ; apparatus worked by steam for artificial respiration ; Ludwig's "Schlagwähler" ; kymograph for a long roll of paper, and high-speed drum kymograph, both worked by steam ; high-speed drum kymograph worked by weights ; two drum kymographs of the spring pattern ; four high-speed drum kymographs, worked by an electric motor ; two single drums, to be revolved by hand ; four "Basel stands" for the fine adjustment of recording levers ; Zeiss scales and other instruments for reading and measuring curves, including a planimeter ; electro-magnetic chronographs and control hammer ; seconds pendulum ; interrupter clock ; automatic dry-contact tuning-forks ; short-beam quantitative balance ; copper voltameter ; milliampère- and ampère-meters ; Wiedemann-duBois galvanometer, with coils of high and low resistance ; Haüy's bar, telescope, and milk-glass scale ; capillary electrometers ; ohmmeter, for resistances of from 0.001 to 200,000 ohms ; Edelman's faradimeter ; nine horizontal and two upright duBois induction coils ; a complete collection of duBois-Reymond's other apparatus ; moist chambers and muscle levers ; upright rheochord ; mechanical tetanomotor ; differential rheotome ; Marey's tambours ; cardiographs, stethograph, and explorer of the human muscles ; sphygmographs ; plethysmograph ; two single and one double recording mercurial manometers ; spring manometers ; tonographs ; "stromuhr" ; frog-heart apparatus ; thermo-electric apparatus ; constant-pressure injection apparatus ; two mercurial gas pumps ; large spectroscope ; direct vision spectroscope ; Ladd spectroscope ; four micro-spectroscopes ; heliostat ; twelve micro-

scopes and accessories ; Thoma's microtome ; Anschütz's " Schnellseher " ; numerous instruments and models for the investigation and demonstration of the physiology of sight and hearing ; casts and models of the brain ; Dalton's apparatus for making sections of the human brain.

Anatomical Laboratories

The laboratory facilities of the Department of Anatomy are very complete. The large general dissecting-room accommodates from 220 to 294 students at a time, working in groups of five or seven, respectively, at one table.

The recently completed erection of a plant for the production of artificial cold by the anhydrous ammonia process has enabled the department, through the means offered for the indefinite preservation of fresh subjects by the cold-storage system, greatly to increase the amount of material available for laboratory work ; and has also rendered it possible so to regulate the temperature of the general laboratory, that the work can be carried on without difficulty during the warmer months at the beginning and close of the academic year.

During the past year the laboratory for advanced morphological research has been completed, equipped with apparatus, and provided with steam power and plant, electricity, and ammonia-freezing and corrosion plants.

Every facility for advanced and research work in morphology is here extended. The established connections of the department furnish abundant, human and comparative material, both mature and embryonal.

The Bacteriological Laboratory

A special section of the northern wing of the College of Physicians and Surgeons in the Department of Pathology, is devoted to the work of bacteriology. The laboratory for the morphological and biological study of micro-organisms is suitably equipped, and the systematic study is greatly facilitated by the maintenance of the large collection of the known forms of bacteria, under cultivation. A separate laboratory is assigned to the chemical study of the metabolic products of germ life. The facilities for work in photo-micrography, which are maintained in connection with the department of Pathology, are accessible to workers in bacteriology.

MUSEUMS AND COLLECTIONS

Collections of the Department of Mathematics

The Department of Mathematics possesses a large number of models, charts, and instruments. An elaborate set of models illustrates the metric system of weights and measures. A set of about fifty models of elementary solid and spherical geometry is intended to exemplify the demonstrations contained in Davies' Legendre. These are made of cherry wood with markings of inlaid ebony, and are of unusually large size. There are several similar models representing the different plane sections of the cone. A series of wooden models, constructed by Schroeder of Darmstadt, also illustrates elementary solid ge-

ometry, and contains, in addition, examples of all the different forms of the surfaces of the second order. There is a series of models of descriptive geometry, also constructed by Schroeder. The horizontal and vertical projections are traced upon boards solidly joined together at right angles and of convenient size to allow in general the representation of three different models or of three different views of the same model. The form and construction suggest a division of these models into two classes: (1) the representation in metal of lines and surfaces, adjusted upon axes, the projections of several of their positions being given; (2) the representation of solid bodies in hard wood, including the exhibition of their plane sections in various directions and the intersections of different surfaces and solids.

A collection of models, which was presented to the department by President Low, having been purchased by him from the German University Exhibit, at the Chicago Exposition in 1893, illustrates analysis situs, theory of functions of a complex variable, surfaces of higher order, their singularities and curvatures, and line-geometry.

A series of charts illustrates the theory of plane algebraic curves, especially those of the fourth order, the resolution of higher plane singularities into equivalent elementary singularities, the expression of functions by means of infinite series and infinite products, and conformal representation by means of algebraic and elliptic functions.

Among the instruments of the department are an Amsler planimeter, many instruments for executing geometrical constructions upon blackboard and paper, a collection of curves of different sizes in wood and hard rubber, and several pieces of apparatus for describing the conic sections upon the blackboard in accordance with the well known kinematic methods.

The collection of mathematical works in the University Library is especially rich in sets of collected works of mathematicians. All the mathematical journals of any importance are regularly received, and the library possesses complete sets of most of them.

Collections of the Department of Mechanics

The department is supplied with various machines and models of machines for illustrating the so-called mechanical powers, with balances, dynamometers, air pump, hydraulic pumps, and other apparatus to which reference is made in the course of theoretical studies. The department has a well-equipped electrical research laboratory under the direction of Professor PUPIN. A limited number of advanced students can be accommodated in it. In addition to its own appliances, the department has access to the apparatus of the allied departments, especially that of the Department of Electrical Engineering, thus affording the facilities of an extensive equipment to the students in advanced work.

Chemical Museum

There is a Chemical Museum containing nearly 8,000 specimens illustrating the chemical elements in the various forms in which they occur in nature as well as the compounds which they form with each other. In addition to this there

is a collection of apparatus and instruments designed to illustrate methods of chemical analysis and methods of investigation into the chemical properties of matter. Organic chemistry is specially illustrated by two collections, one including the representatives of all groups of fatty compounds, such as hydrocarbons, haloid ethers, oxygen ethers, alcohols, aldehydes, ketones, organic acids, acid anhydrides, amines, amic acid, amides, etc., aromatic hydrocarbons, halogen derivatives, phenols, aromatic alcohols, nitro bodies, azo bodies, derivatives of naphthalene, anthracene, phenanthracene, diphenyl, etc.

Collections of the Mineralogical Department

The Mineralogical Collection consists of about 26,000 labelled specimens, and includes, in addition to the main collection, a large suite of pseudomorphs, a collection illustrating the physical character of minerals, a collection of natural crystals, and a collection of New York City minerals. Arranged in wall cases are large specimens, showing the associations of minerals. There are also three separate student collections of average specimens, more than 6,000 in number; several thousand unlabelled specimens used in determinative work, about 500 sections of minerals, and 1500 crystal models in wood and glass.

Among the collections of mineral that have been presented to the department from time to time are some that possess historic value, among which may be mentioned the Gillmore collection, made in Paris under the direction of the Abbé Haüy, and presented by the late Gouverneur Kemble of West Point; a collection of Schulsberg (Wis.) stalactites, exhibited at the Sanitary Fair; a fine suite of Russian minerals presented by the Czar; a collection of American minerals presented by the late Geo. T. Strong; two of the finest cerussites in the world, the Julian collection of minerals from Chesterfield, Mass., the famous collection of Professor How, of King's College, Nova Scotia, and a very valuable collection made by Dr. Egleston in Japan.

In addition, a large number of gifts of one or more specimens have been received, and these have been supplemented by careful purchasing and exchanging, so that the collection fairly ranks as one of the two or three great mineral collections of this country.

The Geological Museum

Geology, Palæontology, Zoölogy

The Geological Museum occupies, together with the adjacent lecture-room, the entire upper floor of the School of Mines building on Fourth Avenue. It has been especially arranged for purposes of instruction, but displays in addition the larger, more valuable, and more interesting specimens. The largest portion of the museum is occupied by the collections illustrative of stratigraphical geology and palæontology. They are arranged in floor cases and wall cases, and are divided into three rooms, separated only by open arches, so that the Archæan and Palæozoic rocks are in one, the Mezozoic in another, and the Cenozoic in the third. In the tops of the floor cases the typical fossils and rocks are displayed, while in the trays of the closed cupboards under them the

fuller series are stored. In the wall cases the stratigraphical sequence is indicated in the superposition of shelves, and explanatory charts are provided to indicate the general relations. There are several additional cases, containing specimens and models illustrative of physical geology, such as folds, faults, slips, volcanoes, and the Ward collection illustrating the stratigraphical succession of New York State. There is also a series of Ward's casts of large fossil skeletons. There are also several cases of Palæozoic fishes, which include the types of the genera and species described by the late Professor Newberry. The museum contains as well a study collection of fossils, arranged on a purely biological basis, which is used to illustrate the lectures in palæontology, and is always accessible to students.

In economic geology a most complete exhibition is made of the mineral resources of the United States, and in less degree of other lands. The specimens are arranged in floor and wall cases, the large ones being in the latter. They are grouped according to the economic products or metals that they afford. This collection is thought to be unequalled in its completeness, outside of the National Museum in Washington.

These collections are estimated at nearly 100,000 specimens. They were chiefly gathered by the late Professor Newberry, but accessions are continually being received.

The Herbarium and other Botanical Collections

The Herbarium contains about 500,000 specimens, being one of the largest in America; additions are at present made to it at the rate of about 20,000 specimens a year. It comprises: (1) The collections accumulated by Dr. Torrey, which came into the possession of the University at his death in 1873. (2) The collections of Professor C. F. Meisner of Basle, Switzerland, presented to the University about the time of Dr. Torrey's death by Mr. John J. Croke. (3) The collections of Dr. A. W. Chapman of Appalachicola, Florida, presented by Mr. Croke at the same time, containing the types illustrating Dr. Chapman's *Flora of the Southern United States*. (4) The mosses of the late C. F. Austin. (5) The mosses of the late Dr. J. G. Jaeger, recently acquired. (6) Miscellaneous accumulations since Dr. Torrey's death, now making up more than one-third of the whole collection. The herbarium is rich in types of species described by Dr. Torrey, Professor Meisner, Dr. Chapman, Dr. Asa Gray, Mr. Austin, Professor Britton, and Dr. Morong. The various collections are now all arranged in a single series, but each sheet is identified by a designative label or stamp. There are also extensive collections of fruits, seeds, woods, and material illustrating economic botany, placed in cases and drawers.

The portion of the University library classified under botany is shelved in the room containing the herbarium. It now contains 3700 bound volumes and about 5000 pamphlets and extracts. These numbers do not, however, represent the whole reference strength of the collection, for all general works, scientific journals, and publications of general scientific societies are shelved in the main library. All the regularly published journals devoted to botany are received, and the sets of most of them are complete.

Museum of Human and Comparative Anatomy

Much work has been done in the formation of a Museum of Human and Comparative Anatomy, the ultimate design of which is to present, in as complete a manner as possible, a view of the evolution of the forms of animal life, and of their natural relations, both in series of natural groups and in the comparative and relative position of organs and systems. Even the approximate attainment of this aim will require much time and work. For the present, the energies of the department are directed toward placing in position the very abundant vertebrate material already on hand, and the collection of models and casts pertaining chiefly to human anatomy. The collection, both as regards groups and the individual preparations, is designed for the illustration of both elementary and advanced courses.

In addition to the museum collection proper, the department is constantly adding to a large collection for advanced study and research.

A study-collection of human osteological preparations is so administered as to enable every student to take out the different osteological series and retain them for private study as long as required.

LIBRARIES

The University Library now contains over 215,000 bound volumes, and accessions are made to it at the rate of from 15,000 to 20,000 volumes annually. It is rich in serials and society publications. (The number of volumes classified under Pure Science is about 27,000.)

The Library of the New York Academy of Sciences is also stored under the roof of the University library building, although in a separate room of its own. It was begun in 1817 and contains the proceedings of most of the scientific societies of the world, which are and have been obtained by exchange. The files are especially rich in these. It is essentially a scientific library of reference. (About 10,000 volumes and bound pamphlets.)

The Astor Library and the Library of the American Museum of Natural History are also accessible. The former is particularly rich in serials, standard works upon all branches of science, and proceedings of learned societies. (About 60,000 volumes in science.) The museum library contains a full series of systematic works upon zoölogy, besides a large collection of general works. (About 20,000 volumes.)

AMERICAN MUSEUM OF NATURAL HISTORY

The American Museum of Natural History faces Central Park at 77th Street. By an agreement between the Trustees of the University and of the Museum, effected in 1892, qualified students of the University have access to the large exhibition and study collections under certain regulations. The museum is especially strong in the departments of geology, mineralogy, invertebrate palæon-

tology, ornithology, and mammalogy. Recently a department of vertebrate palæontology has been established under Professor Osborn, as curator, and extensive collections of fossil mammals are being made in the West. These will afford new materials for original investigations.

MARINE BIOLOGICAL LABORATORY

The Marine Biological Laboratory at Wood's Holl, Mass., has a summer school of Zoölogy, Botany, and Physiology, and forms a valuable adjunct to the biological instruction of the University. In addition to the general advantages offered there, two investigators' rooms are subscribed for by the University for the use of the Departments of Zoölogy and Physiology.

ACADEMIC CALENDAR

- 1896—June 10—Commencement, Wednesday. Columbia College and
School of Mines examinations for admission begin.
June 13—Examinations for admission end, Saturday.
Sept. 28—Examinations for admission begin, Monday.
Sept. 30—Matriculation and registration begin, Wednesday.
Oct. 5—First term, 143d year, begins, Monday.
Nov. 3—Election day, Tuesday, holiday.
Nov. 26—Thanksgiving day, Thursday, holiday.
Nov. 27—Friday, holiday.
Dec. 21—Christmas holidays begin, Monday.
- 1897—Jan. 2—Christmas holidays end, Saturday.
Jan. 25—Mid-year examinations begin, Monday.
Feb. 6—First term ends, Saturday.
Feb. 8—Second term begins, Monday.
Feb. 12—Lincoln's birthday, Friday, holiday.
Feb. 22—Washington's birthday, Monday, holiday.
Mar. 3—Ash-Wednesday, holiday.
April 16—Good-Friday, holiday.
May 17—Concluding examinations begin, Monday.
May 30—Memorial Day, Sunday.
May 31—Monday, holiday.
June 9—Commencement, Wednesday. Columbia College and
School of Mines examinations for admission begin.
June 12—Examinations for admission end, Saturday.
Sept. 27—Examinations for admission begin, Monday.
Sept. 29—Matriculation and registration begin, Wednesday.
Oct. 4—First term, 144th year, begins, Monday.



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